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For 1893

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ELECTRICAL ENGINEERING AND LITIGATION.

PERHAPS no other industry has suffered more from patent and other litigation than electrical engineering. This, no doubt, is due, in a large measure, to the sudden rise and progress of the trade. In the early days many defects and wants were apparent in the methods and appliances used by the electrical engineer. Inventors were continually working on the subject, and improvements were made in every method and appliance used. Most of these improvements have been patented, and some few of them taken up by powerful companies. Over these few there has been a great deal of litigation, very profitable to the experts and lawyers, but, in some respects, disastrous to the trade.

One feature in the litigation, towards which attention may be directed, is the patentee's delay in taking action against alleged infringers. This delay is the cause of all the trouble arising from the cases hitherto fought out. Take, as a typical instance, the case just decided in favour of Dr. Hopkinson's patent. This patent is dated 1882, and the first decision against infringers is dated 1893. In the Swan-Edison lamp case there was a delay of eight or nine years before any action was taken. In the compound-winding case there was also a delay of some years. These delays are, undoubtedly, beneficial to the patentee, but they are unfair to the public and the electrical engineering business.

In the case of the Hopkinson patent, a great many companies and corporations have been advised by experts to adopt the system which was covered by this patent, and having done so, now find themselves liable as infringers, whereas if the patentee had taken action promptly against the first infringers many years ago, the patentee's claims would have been recognised and satisfied, or some other system adopted. Further than that, experts, in advising companies and corporations, would have held the patentee's claims up to the full view of their clients. If the consequences of infringement fell only upon experts and manufacturers, there would be not much to complain of, but in this case the consequences fall upon the innocent investors in electrical distribution schemes on the three-wire system. Experts, manufacturers and contractors, must all have been fully aware of this patent covering the three-wire system, and ought to have borne it in mind when advising. It cannot be expected that investors and other people who find the money to establish electrical distribution should know anything regarding patentees' claims.

On the other hand the patentee, by delaying action, allows large interests to grow up around his invention, and thousands of pounds are spent in establishing and perfecting it in practice. This goes on for years, the patent becoming more and more valuable as more people adopt it and invest in it. Then when a great deal is at stake, action is taken, and the alleged infringers being so deeply involved, very

large financial liability must in any case be faced whether by private arrangement or by a test case in the law courts. To acknowledge the patentee's claims after working for years, or to challenge his patent rights is an equally expensive business, and whether the one course or the other is pursued the deleterious effect is the same on the industry.

We do not by any means insinuate that these delays are intentional on the part of patentees engaged in any case whatever, but there they are, and they are an evil which we think might be removed by some modification of our patent law.

A patentee should be compelled to proceed against infringement of his specification within a given time after it comes to his knowledge, or give up all claims under his patent.

And the alleged infringer should either immediately accept the challenge and defend his position or admit the patentee's claims within a given time.

And further, if a patent in use is not disputed or remains unchallenged on the score of anticipations or prior publications within a given period after the patent is published it should not be allowed to be challenged on those grounds after that period expires.

By some such provisions as these the delays in settling patent claims might be avoided, and the great waste of money involved in actions taken ten years or more after infringement commences, might be prevented.

In our country, where patents are granted without official examination as to novelty, anticipations of patents are frequent and vexatious, but this is also due to the fact that inventors or their agents do not take advantage of the period allowed for examination and opposition provided by our Patent Laws before any patent is granted. On this point our Patent Laws might also be amended. Cases under the opposition stages of applying for a patent are not conducted before any trained scientific authority, and all cases require attendance in London of highly-paid agents; these and other difficulties render the British Patent opposition stage valueless for its avowed purpose, and, consequently, one inventor allows another to get a patent for an invention already patented rather than submit to the red tape and expense of an opposition case before an unskilled authority. Nevertheless, this opposition stage might be so improved in its application and working that fewer valueless patents would be issued.

We are always glad to see an inventor victorious in a patent suit; a favourable decision for a patent raises the value of patents in the eyes of most people, and is a wholesome deterrent to those who are prone to reap benefits from another man's labours without recompense; but let the validity of the patentee's claims, the fact of anticipation, or the defences of the alleged infringement, be settled at the outset of the career of the patent.

WHAT IS A CONSULTING ENGINEER?

AN answer to this question was given recently by a well-known shipowner to to a better known banker, in language more forcible than polite. "We do not put our work through consulting engineers any longer," said the shipowner, "we find that they cram the ship full of all sorts of patent devices on which they receive a commission as agents, or in which they are otherwise interested, and which invariably break down and won't work. We find we are far better protected by allowing the ship builder full control."

It must be remembered that the above statement was made by a practical man as the result of his experience. It is, therefore, worthy of serious consideration. A point that naturally suggests itself is, Why should so sweeping a condemnation of consulting engineers be made, and how do consulting engineers incur such universal odium? The reasons are, we submit, excessively easy to find. We will not enunciate these reasons *seriatim*, but we will give our definition of a consulting engineer, and we will feel sure that all who have had experience of work carried out under so-called consulting engineers will very readily appreciate the feelings which prompted the shipowner to adopt such views as are set forth in the fragment of conversation which we quoted at the commencement of this article.

There is no more difficult and thankless task (the efforts of a patriotic man, perhaps, excepted) than that which enters every day into the ordinary routine of a consulting engineer's practice. On the other hand, nothing is easier or more simple than to be an unconscientious consulting engineer. A not uncommon course of events is the following:—

Messrs. Parmgreese and Noodle (consulting engineers), have friends on the Local Board of some well-to-do town or district which is contemplating the introduction, say, of electric light. By dint of the judicious exercise of methods which have on former occasions proved their value, Messrs. Parmgreese and Noodle, consulting engineers, are appointed by the Local Board to draw up a "scheme."

Messrs. Parmgreese and Noodle undertake, as consulting engineers, to draw up schemes on every imaginable subject, and their usual course is to go to some well-known firm of contractors and promise—for a consideration—to place the contract with them if they will supply Messrs. Parmgreese and Noodle with a suitable "scheme" and specification and take all the risk. It is a fundamental principle of Messrs. Parmgreese and Noodle to avoid all responsibility as regards the results of their consultations with their clients.

The matter may go through, or it may not. If it does not go through, Messrs. P. and N. are none the worse, but somewhat the better, by a gratuitous advertisement in the technical journals to the effect that Messrs. P. and N. have been instructed by the Local Board to prepare a scheme, &c.

If it does go through, Messrs. P. and N. get their fees and charges and petty disbursements, and also some consideration and thanks at the hands of the contractors. Messrs. P. and N. of course know how to draw a specification so that only one firm can really tender on it.

Is anyone prepared to deny that the foregoing is typical of the method of so-called consulting engineers, who of recent years have become so plentiful as to bring disgrace and dishonour on what should be a noble and honourable calling?

Is anyone prepared to deny that the words "consulting engineer" in the left-hand corner of business letter paper do not call up a cynical smile on the face of the readers if they "know?" Are these two words not suggestive of hypocrisy and dissimulation in the vast majority of existing cases?

Is anyone prepared to deny that the honest man of busi-

ness, whether professional or otherwise, whose word was more binding on him than all the agreements and contracts in the world, whose honesty of purpose was never questioned, and whose integrity was above suspicion, is not fast becoming extinct?

Is it not true that a good business man is understood to know how to work everything for his own advantage, and is bound by nothing, and influenced by nothing, outside of legal restrictions and fears of legal consequences?

We will now attempt to give our views as to what characteristics a consulting engineer should possess, and why he should possess them.

First, let us enquire into the functions that a consulting engineer may legitimately be considered to discharge in respect to such a matter as the foregoing.

It is, above all, the duty of a consulting engineer to thoroughly grasp his client's requirements, to advise upon the best way of fulfilling these requirements, and to put these requirements, and the method to be adopted in carrying them out, in such plain, simple, and precise technical language, that those who have to base their prices for the work on the technical description or specification before them understand, distinctly and exactly what has to be done.

This is, strictly speaking, as far as a consulting engineer should go. But it is obvious that no one is better qualified to superintend the erection of works than he who designed them. Consequently we consider it legitimate, and very much in the interests of the client, that the consulting engineer should be retained to superintend the execution of the contract, and that his certificate should be a condition precedent to payment being made to the contractors.

It will be unnecessary to enumerate every legitimate way in which a consulting engineer may act, but it is, above everything a *sine quâ non* (we may be forgiven the pleonasm), that a consulting engineer's judgment and opinion should be unbiassed by even personal considerations. To take an instance. It is as reprehensible for a consulting engineer to allow a contractor to "mention his name" to a possible client for whose work this contractor will ultimately tender in competition with others, as it would be to accept a bribe from the contractor. In either case he puts himself under an obligation to the contractor, and this is certainly not fair towards his client. A client has a right to expect, and to know that, in discussing his affairs with a consulting engineer, he will have the advantage of an impartial and unbiassed consideration from a technical point of view; that he will be honestly advised; that if he be advised to buy Smith's dynamo and not Jones's, it is because of some defect in Jones's dynamo and not in his powers of persuasion; that the consulting engineer is not on terms of personal friendship with any firm of contractors for other reasons except those based upon an appreciation of the honest and disinterested manner in which the contractor had carried out all work entrusted to him for many years. In short, that, if the consulting engineer's advice turn out to be bad advice, the mistake has been made honestly, and is not the result of any undue influence or bias.

We are of opinion that, without doubt, the methods of conducting their business, adopted by a large majority of consulting engineers, leave very much to be desired, and we think that this is in a great measure due to the fact that no body or institution exists whose members are pledged not to accept any fee or remuneration, whether in money or in kind, other than the fee agreed upon between themselves and their clients. The Institute of British Architects does not allow its members to advertise or to take commission from a contractor or patentee, with the result that, when dealing with architects who are Fellows of this Institute, the public has some guarantee of good faith and integrity. But there is no similar condition or restriction imposed upon members of any engineering institution, which has entailed, as a consequence, that amongst engineers the professional and commercial element are inextricably mixed up.

What would be said of a man who styled himself "builder and architect" or "consulting physician and dispensing chemist?" and yet no one expresses any surprise that a firm of engineers advertise themselves as "consulting engineers and contractors." An attempt is made to explain away the latter anomalous style—at least as regards electrical engineering—by the argument that inasmuch as electricity is a young branch of engineering, it must follow that the contractor knows more about the matter than the consulting engineer. This is undoubtedly a tenable argument, but we submit that it is beside the point. We do not suggest that any objection be offered to a man being consulted simply because he is interested in some manufacturing concern, provided the intending client acts in full knowledge of the fact, but we insist that it is morally wrong for a man to style himself a consulting engineer only, and to conceal, as far as he is able, from public knowledge, that he is prepared to contract or that he is agent for any speciality. And we have little hesitation in saying that, with the exception of the very highest developments of art and science (the sculptor, the artist, the musician in the highest sense, where the adviser of necessity carries out the work on which he advises), it is difficult to conceive how an impartial opinion can be expected from a man who derives some pecuniary benefit by the sale, through his influence or advice, of any commodity. We do not pretend to reform the profession in an article of two or three columns, but we would urge upon the serious consideration of those who, by their living example, have done, and still do, so much to preserve the honour of professional engineering, that it is daily becoming more imperative that steps should be taken to prevent the abuse of the term "consulting engineer."

The public should know—and, we think, have a right to know—with whom they are dealing, they should be able to recognise, by the nature of the professional man's qualifications, whether he is pledged to do his best to preserve impartiality of opinion, or whether his opinion is liable to be conditioned by, or dependent on, the persuasive powers of the manufacturer.

We recognise the difficulty of winnowing the wheat from the chaff, more especially as the amount of wheat must of necessity be very much the smaller, but we do not forget that unity is strength, and that the chaff, though perhaps locally adherent, is scattered to every point of the compass by the first breath of the wind of adversity, while the wheat, irrespective of quantity, possesses an inherent principle which renders it capable, under judicious manipulation, of being formed into the bread which shall infuse new life into professional engineering.

THE THIRSK RAILWAY ACCIDENT.

THE report of Major Marindin, the Board of Trade Inspecting Officer, appointed to inquire into this accident, has now been published; and, as was to be expected, one of the chief points commented upon is the fact that had the mechanical and the electric signals been interlocked there would have been little, if any, possibility of the collision having occurred. Our previous comments have been in the same direction. Major Marindin very strongly urges railway companies to adopt as speedily as possible one of the several forms of interlocking, which are already in use, and applicable to their systems of signals. It is pointed out that to do so would occupy some time, and it is suggested that, until such is done, it would add to the safety of the traffic if that course, which prevails on some few lines, of not offering the preparatory, or "Be ready" signal to the box in advance, for a following train, until that already despatched has been signalled clear, were followed. To do so would undoubtedly add to the security of the traffic, but it would practically, where the line is full of trains, reduce its capacity by one-half, and this we take it could not possibly be entertained. Whether, however, seeing that interlocking the electric and mechanical signals will at once obviate all necessity for this, it is not a further reason for the early adoption of interlocking, is a fair question for consideration on the part of railway companies. It is particularly noticeable that the inspecting officer in no way confines his remarks and suggestions to the North Eastern Railway Company, but that they are directed to all railway companies alike.

In considering the question of interlocking there crops up, of course, the oft-repeated objection that if a train became divided from any cause, the system would not save a collision with the portion remaining upon the line. Major Marindin regards this as so unlikely to arise as practically to preclude its influence in dealing with the subject. We would point out that if interlocking is to be adopted, an attachment to the last vehicle, such as should operate some electrical device, would entirely obviate any difficulty on this score. That such a means could readily be found there is little doubt. Once let it be understood that the railway companies are not averse to deal with the question, and they will find plenty of workers ready to aid them in effecting their wishes.

The report deals in a masterly manner with other equally important questions which do not, however, come within the scope of an electrical journal, but which will be read with much interest by most people. It is, indeed, one of the most important and fruitful documents which have been issued for some time past in relation to railway accidents.

Converting Alternating Currents into Continuous Currents.

MM. HUTIN AND LEBLANC have for a long time been engaged in the task of producing a transformer which should convert alternating into continuous currents. Such an apparatus would certainly be useful in many places where electrolytic processes, charging accumulators, &c., are going on, and where the energy can only be obtained through alternating current mains. It is almost impossible without the aid of diagrams to give an adequate idea of the latest machine designed by MM. Hutin and Leblanc, and which is fully illustrated in the current number of *La Lumière Electrique*, but we intend to reproduce the article, or at least the most important parts of it, in an early issue. Judging by the appearance of the apparatus as depicted in *La Lumière Electrique*, we are inclined to think that it is too complicated for commercial uses, although very ingenious. The commutators and moving brush holders must require some attention, and admitting a reasonably high efficiency in this new transformer, it still seems that an alternating current motor driving a continuous current dynamo would answer the purpose at least equally well without costing any more for manufacture or maintenance. If there is a variation in the output of the transformer of MM. Hutin and Leblanc, there will probably also be sparking at the numerous contacts, and consequently the necessity of frequent attention. The method of providing movable commutators and stationary brushes appears still more complicated. From the scientific point of view, however, the invention of MM. Hutin and Leblanc is exceedingly interesting and deserves the fullest attention, and in all probability the present apparatus may be the forerunner of important developments in the direction of converting alternating into continuous currents.

The Singing Telephone.

THE curious phenomenon observed when a telephone receiver is placed in close proximity to a sensitive microphonic transmitter with which it is in connection, has recently been written about as if it were a new discovery. As a matter of fact the mutual reaction effect which gives rise to a continuous loud singing or whistling noise was observed in the very early days of the microphone, by Prof. Hughes (see ELECTRICAL REVIEW, June 15th, 1878, page 255). The discussions relative to the theory of the action strike one as being "much ado about nothing."

The Electric Lighting of Brescia.

LIKE ourselves, our Special Correspondent cannot but feel surprised at the singular and most uncalled-for letter of Dr. von Wurstemberger, published in our issue of January 6th. This gentleman seems to have a special gift of erroneous generalisation. Because we showed that the conditions proposed by the municipal authorities of Brescia were such as practically to preclude the commercial success of the undertaking, it is insinuated that we are impugning the character and the reputation of the citizens of Brescia! Because we made known the stipulations of the Brescia Corporation, we are accused of discouraging British enterprise on the Continent! And because we did not quote the entire condition from beginning to end, it is insinuated that we—or our Special Correspondent—omitted whatever did not suit our purpose! This is exactly the style of advocacy for which "Old Bailey barristers" are celebrated. It so happens that neither we nor our Special Correspondent have any "purpose" to suit, except keeping British electrical engineers acquainted with the prospects of every electrical undertaking. If Dr. von Wurstemberger thinks that we have been too severe upon Brescia, let him, as he has evidently obtained a copy of the conditions, circulate them among his friends. If then he or they think the undertaking offers a prospect for the contractor, let them enter upon it "with what appetite they may." We, at least, have done our duty to our readers and to the public.

Small Motors.

MANY amateur electricians are very desirous of building small motors, but are not generally able to work out in any way a suitable design for themselves. A paper of interest to such will be found in a recent number of *l'Electricien*, in which full calculations, &c., are given of two small motors of about $\frac{1}{8}$th H.P. The calculations are reliable, and if any of our readers are ambitious of making a small machine of the kind, they could not do better than follow the directions given therein.

ELECTRIC LIGHTING IN A VIENNA CATHEDRAL.

[FROM OUR OWN CORRESPONDENT.]

SOME time ago I informed you that the celebrated cathedral of Vienna (St. Stephen's) had been provided with the electric light, and that the new illuminant was giving full satisfaction. But now the *Neue Freie Presse* communicates the following paragraph :—

"Although experiments made by the firm, Siemens and Halske, on October 15th, 1892, and on the following days, on the illumination of St. Stephen's Cathedral with arc lamps, gave the appearance as if the ecclesiastical authorities were agreeable to the introduction of the electric light, the Professor of Theology, Dr. Wilhelm Neumann, editor of a journal published by the Vienna Association for the Preservation of the Cathedral, states that the competent clerical authority has resolved to renounce the introduction of the electric light for *liturgical æsthetic and practical reasons*. It seems that in this conclusion the opinion of Prof. Dr. Neumann has been chiefly decisive. He declares in the journal above mentioned that the management of the cathedral, who were only at the last moment informed of the experiments to be conducted, protested at once from artistic reasons, and in addition declared that it could not undertake the responsibility for a conflagration which might arise from a defect in the leads. To be sure a specialist of the first standing pronounces the leads supplied by Siemens and Halske as absolutely safe with respect to fire. But the Cathedral management suggested elemental occurrences, or the fall of one of the large and heavy roof tiles, &c., as being within the sphere of possibility, and regarded the danger of fire as *by no means absolutely excluded*.

"The late master of the cathedral buildings would certainly have protested like the present management. He allowed no one access to the lofts of the cathedral without special permission, and no stranger on any consideration. With the introduction of the electric light this fundamental principle would be untenable. The establishment of a special fire-service for the lofts of the cathedral alone would be required, if the possibility of a conflagration were not to threaten St. Stephen's and the entire city!"

With reference to this far-fetched and theatrically written communication, which aims at excusing the conduct of the Cathedral management, I will mention that according to my recollection the experimental lighting of a Catholic church in Vienna was considered, and that this project was rejected on account of a liturgical difficulty. We might, therefore, have expected that the use of the electric light in the Cathedral at Vienna would have been objected to, even if it had not been subsequently remembered that "the risk of fire was not by any means absolutely excluded," although it is certainly more æsthetic and less dangerous for fire than the eminently "liturgic" illumination with candles. It is certainly painful to learn from the open admission of the Divinity professor, Dr. Neumann, that electricity is now burdened with liturgical opposition. It is impossible to conceive why the Catholic church should assume a less benevolent attitude towards the electric light than towards gas, which as it is well known has been introduced in many Catholic churches.

SHOULD ELECTRICAL ENGINEERS BE SKILLED MECHANICAL ENGINEERS?

BY SYDNEY F. WALKER.

IT has been frequently stated during the past few years, since electric lighting has become practically successful in fact, that no electrical engineer has any chance of success who is not also a skilled mechanical engineer. In fact, so far has this view been carried, that young men training for electrical work, have been advised to qualify themselves, as fully as they are able, in mechanical engineering first, and to pick up what they can of the principles of electricity afterwards.

As with so many of these things, there is a substratum of truth underlying the argument; but it has been given very much greater prominence than it deserves, or than, in the writer's opinion, is good for the future of the industry. It is undoubtedly true that an electrical engineer should be familiar with the laws of mechanics, and, as far as he can be, with the principles of mechanical engineering; and the more he knows of both of these, the better will he be able to deal with some of the problems and difficulties that arise.

It is also equally true, as pointed out in the article in the ELECTRICAL REVIEW of this week, that for central station work, just as for ocean steamers, the coal bill is one of the most important items. Every fraction of 1 lb. that can be saved per H.P. is so much towards paying a dividend on the capital.

But the coal bill, and mechanical engineering generally, are only items—very important items it is true—in the whole of the arrangements, and it would manifestly be as unwise to concentrate one's whole attention on the one item of the coal bill, or the item of the lubrication of the engines, to the exclusion of the other items, as it would be for the leader of a party in Parliament to concentrate his attentions entirely on a few of the members of his party, to the exclusion and neglect of the others, no matter how important the individual members might be in themselves. What is true of mechanical engineering is equally true of chemistry, and of other subjects also.

Further, it by no means follows that because electric lighting has a "boom" now that all those who are training for electrical engineers will find their life's labours in that branch alone; and even if they do, the engines and boilers are not the only parts of the apparatus that require attention. Nor, if the matter be given a little thought, is it at all certain that they are the most important parts, in the sense that they require the most careful thought on the part of the superintendent of the lighting station, or the most highly trained skill?

The arrangement and working of engines and boilers is now thoroughly well understood, and there is no difficulty in getting men in almost any locality who can fire up, and who can keep their engines running without breakdown, provided that both engines and boilers are properly designed, properly made, and carefully laid down; but this is the work of the engine builder, not the electrical engineer.

On the other hand, from the dynamo outwards all is more or less new, all require that the eye and the whole of the senses of the engineer in charge should be constantly on the strain, ready to detect and provide for incipient causes of failure. But with the one exception of lubrication, which after all may usually be left to the engine-man, the whole of the problems and difficulties with which the engineer in charge will have to deal are either electrical problems, pure and simple, or electro-chemical.

Again, it is more than probable that before very long, the source of energy employed to drive dynamos for central electric light and power stations will be to a large extent water power. The water which passes through every town of any size, if caused to deliver up some of its pressure before entering the town, would go a long way towards furnishing the lights required by the town. The energy also which is expended uselessly in our rivers and streams, in friction within their own beds, could be largely utilised by means of proper arrangements, and probably will be before very long.

When this takes place, an entirely new branch of mechanical engineering will be opened up, for which the special experience gained with steam boilers and steam engines will not be of much service. And it must be remembered that most of those who advise young engineers to study mechanical engineering, mean steam engines and boilers.

Beyond this, again, too, is the possibility of the solution of the problem involved in the direct conversion of heat into electrical energy; and when this takes place, where will the knowledge of steam engines come in? The writer does not wish to be misunderstood in this matter. By all means get as much knowledge of mechanics, of mechanical engineering of high and low speed engines, of single and double cylinder engines, of simple, compound, triple and quadruple expansion engines, of governors which act on the slide, and which act as expansion valves and those which act on the throttle; of boilers working at 30 lbs., and of boilers working at all pressures up to 150 lbs.; of mechanical stokers of the various types and their advantages over hand firing; of different kinds of tubes for boilers; of the effect of different kinds of

water on boilers; of the heating power of different kinds of coals; of the methods of working different kinds of smoke consumers, feed water heaters, fuel economisers, condensers, &c.; but on no account allow the search after knowledge of these to prevent the acquisition of everything that can possibly be learnt about electricity and electrical engineering.

It should be remembered that we are all of us blessed with only one head-piece, and with one pair of hands, and that the time we can devote to learning our work, whether during apprenticeship or after, is strictly limited. Therefore, if we are to make the best use of our time—if we are to take the course best qualified to make us skilled *electrical* engineers—our studies should be principally electrical, only going into other branches when the two happen to overlap, and to enable us to deal with some problem requiring a special knowledge of a particular portion of the sister branch.

In the writer's opinion, we should strive to know all about electricity, and as much as we can about everything else.

STEAM BLOWERS FOR PROMOTING COMBUSTION.

SINCE drawing attention to Mr. Sennett's paper on the prevention of smoke by means of a steam-induced air jet, and the importance attached by him to the presence of more steam in a furnace than is due to the hydrogen present in the fuel, we have had our attention called to an American device for burning small anthracite and bituminous slack coal in boilers and similar furnaces described by Mr. Rufus J. Foster in a paper before the American Institute of Mining Engineers. This device is the McClave grate in combination with an Argand steam blower.

The blower consists of a tube of circular cross section which delivers air into the ash pit of the furnace, the flow of air being promoted by a number of small steam jets issuing from a ring of steam pipe placed in the air tube, an arrangement almost identical with the blower used on the oil-burning locomotives of the Great Eastern Railway to force air into the furnace above the grate. Mr. Foster claims that a small quantity of steam thus introduced is very valuable, but he deprecates any excess, while he recognises that the dissociation of steam in a furnace absorbs as much heat as can possibly be returned by the re-combustion of its elements: he holds, nevertheless, that the oxygen furnished by the dissociation of the steam is supplied at a suitable locality to enable it to perform a useful duty. It is claimed, also, that steam promotes looseness and porosity of the clinker, so enabling the air to pass through the whole body of fuel on the grate instead of producing "forge flames" or "volcanoes," as so commonly is the case with forced draughts; and what should be aimed at in a boiler furnace is neither a radiant heat under a small portion of the heating surface, nor a draught produced by jets in the stack, nor a forced draught under the grate that will turn the fire into a gas producer pure and simple, giving only a third of the heat-value of the fuel; but rather a medium between extremes, that will produce a sufficient volume of gas and furnish oxygen at the proper point to burn it; getting, thereby, not only better combustion, but flame at a high temperature sufficient to envelop the whole heating surface of the boiler, and maintaining a high temperature in the fuel bed.

The special grate which is recommended for adoption with the blower is one which consists of a series of rocking finger bars, the bars being transversely placed in the furnace, and of such form, that by pulling a lever actuating a rod, upon which each bar is pivoted by means of a down-projecting tailpiece, the bars can be vibrated through an angle of nearly 90°. That side of the bar which ordinarily supports the fuel is thereby placed in a vertical position, and the whole fire would drop into the ashpit through the space left between the tilted bars, but for the fact that each bar has a second

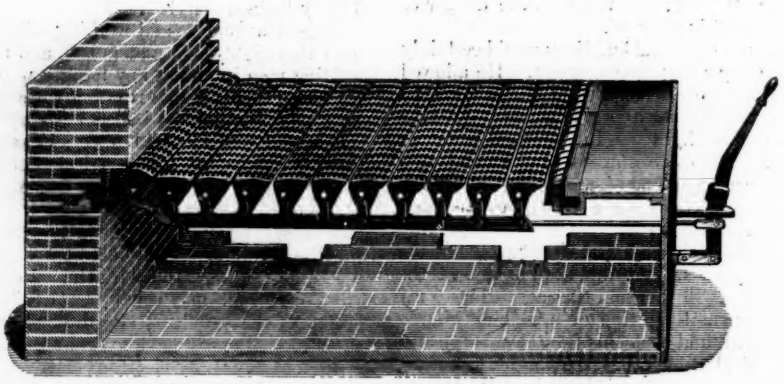


FIG. 1.—SECTION WITH ONE JOURNAL BAR REMOVED.

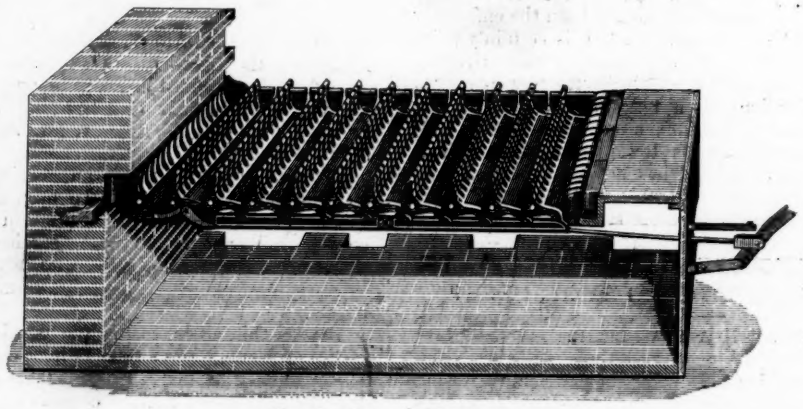


FIG. 2.—CUT-OFF MOVEMENT.

surface, which is vertical in the ordinary position, but becomes, of course, horizontal when the bars are tilted, and these second surfaces support the fire, not, however, without allowing it to drop bodily a short distance into the series of troughs thus formed in the grate surface. Fig. 1 shows the grate in its normal or working position, and the tilted position is clearly indicated in fig. 2. It is obvious that when a contrary movement of the lever brings back the bars from the position in fig. 2 to the normal, the whole of the material which has occupied the pockets will be cut away from the

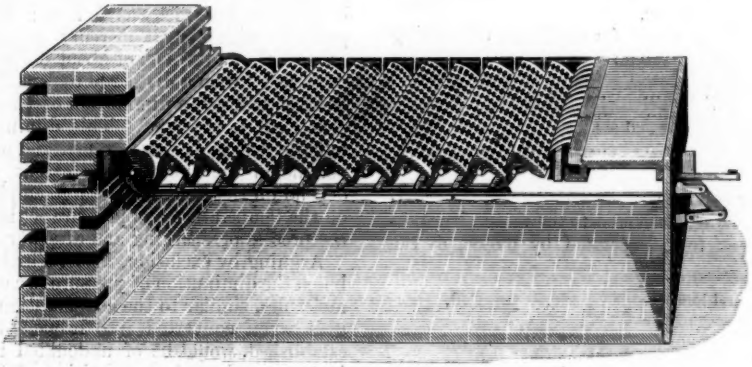
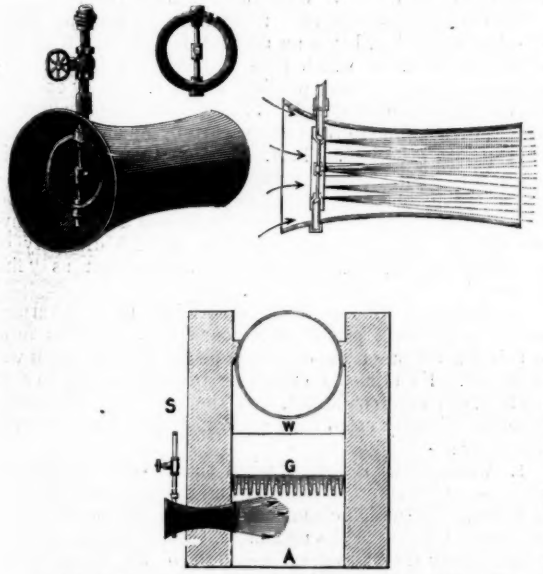


FIG. 3.—SHAKING MOVEMENT.

bottom of the fire, and dropped into the ashpit. By a series of such cuts the whole of the fire could thus be removed, and it is thus possible to very thoroughly cut away the bottom of the fire, in which collect the ashes and clinker, and to do so without too serious disturbance of the mass of the burning fuel.

For merely shaking the fire, the bars are made to tip slightly in a direction opposite from the clearing movement. This is shown in fig. 3. We have no special information as the durability of this grate, which is said to be giving



A, Ash-pit floor; G, Top of grates; S, Steam; W, Top of bridge wall.

FIG. 4.—ARGAND STEAM BLOWER WITH SECTION OF FURNACE SHOWING OPERATION OF ARGAND STEAM BLOWER.

good results with small coal in Pennsylvania; but if the use of steam has the result of preventing the aggregation of the clinker into the well-known semimolten mass, which would prevent it falling into the pockets of the tilted grate, there is no apparent reason why it should not act well.

The cutting-out action is, we believe, novel to most of our readers, and well worth a trial. Excellent results in steam production can be had with apparently very inferior fuels, and we have known the cost of evaporation of 1,000 gallons of water to be reduced something like 64 per cent. by the use of coke breeze and slack in place of high class coal. This result, however, was not attained without some outlay in plant, and it is not possible as a general thing to use small fuels without ample boiler room, a matter not always easy of attainment in densely populated centres. For all bituminous fuels, too, we should be inclined somewhat to question the blowing of all the air through the grate. Fine fuel does require some under grate assistance if any rapidity of combustion is needed, so that the grate surface need not be too large, but bituminous coal must have also a supply of fresh air above the grate in the manner suggested by Mr. Sennett and indeed generally practised in some form in this country. Unfortunately no figures are presented of the rate of combustion attained per square foot of grate, which would have enabled us better to gauge the comparative value of the system as regards the important item of boiler room.

RULES RELATING TO ELECTRIC LIGHTING AND POWER SERVICE AT THE WORLD'S FAIR.*

I.

THE rules relating to electric lighting and power service at the World's Fair, as adopted by the national commission, are given below. These rules have not all been approved by the local committees, however, and are liable to change.

ELECTRICITY FOR INCANDESCENT LIGHTING SERVICE.

All State and territorial World's Fair boards, persons, firms or corporations who may desire to wire their respective buildings for the purpose of lighting same, shall so instal said wiring as to meet with the approval of the director of works before connections can be made with the main circuit.

All power service for generating light will be furnished during the exposition hours by the World's Columbian Exposition from May 1st to October 30th, 1893, at the rate of $8 per 16 candle-power lamp capacity, or the equivalent in lamps of other candle-power. All changes in the location of lamps or appliances when once installed will be made subject to an extra charge, to be fixed and determined by the director-general and the director of works. The incandescent lighting circuit will be operated from 100 to 110 volt alternating circuits.

ELECTRICITY FOR POWER SERVICE.

First.—All contracts to be made with exhibitors for power service shall be executed between said exhibitors, the director-general and the director of works, but the amount of power to be supplied to the exhibitor in each case shall be fixed and determined upon by the director-general.

Second.—The electric motor shall be suitable to operate on a 500-volt constant potential circuit.

Third.—The rheostat shall be constructed wholly of non-combustible material.

* New York *Electrical Engineer.*

Fourth.—The main line switch shall be of the knife blade type and suitable for working a 500-volt constant potential circuit.

Fifth.—The motor shall be erected in position by and at the expense of the consumer and in a manner subject to the approval of the director-general and the director of works.

Sixth.—The service connections to the motors shall be installed, maintained and owned by the World's Columbian Exposition.

Seventh.—No service will be rendered for less than $20. Fractions of horse-power will not be considered except for motors of less than 1 horse-power.

Eighth.—Charges will be made for service of connecting the main line at the following rates :—

For ½ horse-power and less	$10.00 per H.P.
For 1 to 5 horse-power	15.00 „
For more than 5 horse-power and not exceeding 10 horse-power	12.00 „
For more than 10 horse-power ...	10.00 „

Ninth.—Charges for service will be based upon the maximum mechanical horse-power delivered to the motor, irrespective of the class of work to be operated by motor, at the following rates :—

For ¼ horse-power and less	$20.00 per H.P.
For more than ¼ horse-power and not exceeding ½ horse-power	40.00 „
For more than ½ horse-power and not exceeding 1 horse-power	75.00 „
For more than 1 horse-power and not exceeding 2 horse-power	70.00 „
For more than 2 horse-power and not exceeding 3 horse-power	60.00 „
For more than 3 horse-power ...	60.00 „

Tenth.—Special service for motors not exceeding 2 horse-power can be furnished on quarter phase alternating current circuit.

ELECTRICITY FOR ARC LIGHTING.

The aisles of the main building will be illuminated by arc lights free of expense to the exhibitor. A limited number of arc lights will be supplied for private lighting on the following basis, viz. :—

First.—The consumer shall pay the cost of wiring.

Second.—The consumer shall pay for service from May 1st to October 30th, 1893, at the rate of $60 per lamp of 2,000 nominal candle-power.

Third.—Lamps will be suspended from the ceiling and furnished with opalescent globes. If any special fixture is required, it shall be furnished by the consumer.

Fourth.—All care and attendance to the lamps and circuits will be furnished by the World's Columbian Exposition without extra charge.

ELECTRICITY FOR CHARGING STORAGE BATTERIES.

First.—The consumer shall provide lines and all material necessary from the local switchboard from which the current is to be distributed to storage batteries.

Second.—The consumer shall provide all necessary labour and attendance connected with the charging or handling of the batteries.

Third.—Current will be provided at 110 to 220 or 500 volts, at the rate of 10 cents per electrical horse-power per hour.

ELECTRICITY FOR MISCELLANEOUS PURPOSES.

First.—Electricity for special purposes will be subject to special agreement, to be determined at the time of making application therefor.

Second.—Rates will be based either on those of power or those for storage battery purposes, according to the class of work to be performed.

Hampstead Electric Lighting.—A letter appeared in the *Star* of Monday last, from the pen of a "Ratepayer," who protests against the provision of electricity for the convenience of a few of the richer inhabitants at the public cost. He suggests the canvassing of the ratepayers for the purpose of ascertaining the probable number of users of the electric light.

THE ELECTRICAL PROPERTIES OF PURE SUBSTANCES.

THE first installation of an important investigation on the electrical properties of pure substances, is given by Prof. R. Threlfall in the January number of the *Philosophical Magazine*. The starting point of this research dates from 1886, when the Professor, in conjunction with Prof. J. J. Thomson, contributed a paper to the *Proceedings* of the Royal Society. In this paper they discussed an effect produced by the passage of an electric discharge through pure nitrogen. The effect in question was briefly as follows : When a nitrogen tube, provided with a small mercury or sulphuric acid gauge, is exhausted to a pressure of about 8 mm. of mercury, and then "sparked" with a discharge too small to heat the tube in a sensible manner, a diminution of the elastic force of the enclosed gas is observed. This diminution was found to be independent of the size or material of the electrodes, of the volume of the tube, or the extent of its surface but to depend on the kind of discharge employed, and its duration ; on the temperature and pressure of the gas in the tube during the process of sparking and afterwards.

Arguing by exclusion, Profs. Threlfall and Thomson attributed the diminution of pressure to a condensation of nitrogen molecules, similar to the condensation which oxygen undergoes when converted into ozone. Since this property, if established, would be of undoubted interest, Prof. Threlfall, in 1889, undertook a repetition of the experiments, with a view to testing the above conclusion, by an extended examination of the phenomena in question. It was not until December, 1891, that he satisfied himself that the effect was due to the combination of nitrogen with the mercury in the pressure-gauge, under the influence of the electric discharge, and in the presence, as he suspects, of a minute trace of some other substance, the nature of which he has been unable to determine.

The experiments which Prof. Threlfall describes in his paper leave little doubt that pure nitrogen at ordinary temperatures does not condense in the same way that oxygen condenses, whether the discharge be by means of external electrodes or by means of wires fused into the tube.

The experiments described really form the starting point of other researches, hence an account is first given of the method by means of which pure nitrogen may be most advantageously prepared—a problem which, singularly enough, has not hitherto been solved. The methods which have been proposed from time to time are passed in review, and their weak points criticised. Prof. Threlfall then recounts his own experiments. Many pages are devoted to the description of the method finally employed ; indeed, the precautions for ensuring purity are so elaborately devised as to lead anyone who is not conversant with the extreme difficulty of preparing *pure* substances to consider them almost as "finnicking."

A satisfactory tube was finally determined upon, the armed ends of which were placed in mercury cups. In this form of tube the action of the discharge on the pure nitrogen was examined. Experiments extending from April 21st to September 20th were conducted, and the following conclusions were provisionally noted from a consideration of the observed behaviour :—

1. A compound is formed when the electric discharge is passed over a mixture of mercury and nitrogen at a pressure of 8 mm. The action commenced slowly, and increased in velocity till it reached its maximum, then decreases, but continued slowly till at least seven-eighths of the nitrogen was absorbed, the mercury being in excess.
2. It is at first brown, but gradually deepens to black.
3. It decomposes with crepitation at 200° C. (about).
4. It is probably identical with the trimercuramine of Plantamour.
5. It behaves as a dissociable compound on heating and cooling, and can be entirely decomposed by repeating the heating and cooling often enough.

The experiments were then set going again, the electrodes being at various temperatures, and various effects being observed in the glow due to the sparking ; the pressure was carefully noted. These experiments lasted until December 28th, when the apparatus broke down. They were continued with another tube until January 12th.

In the summary of the results given at the end of this paper the following statements occur.

1. Nitrogen can be prepared by a continuous process in a state of great purity.

2. Nitrogen so prepared cannot be caused to condense by any available kind of spark down to a temperature of — 10° C. and a pressure of about 8 mm.

3. When mercury is present, a compound of mercury and nitrogen is formed which is probably identical with Plantamour's compound.

4. The rate of formation of this substance is so irregular as to suggest its formation as being due to the inter-action of an otherwise inappreciable trace of an unknown substance.

5. The compound is dissociable, but under the circumstances of the experiment the dissociation process is not entirely reversible since sufficient heating will permanently destroy it.

6. There are changes in the appearance of the discharge in nitrogen which can be brought about by slight variations of temperature, and possibly of electromotive force, for which no explanation is forthcoming.

This last statement is the one which should set other investigators who may be working in the same direction on the *qui vive*. Here is a definite difficulty, and one of no inconsiderable interest. It is to be hoped that Professor Threlfall may himself find the solution in the course of the investigation of which this paper only forms part 1.

The experimental work has been concluded at Sydney; the paper in which it is described extends over thirty-five pages.

THE RECENT OUTPOURING OF ELECTRICAL BOOKS.

THE following is a copy of a letter which appeared in *Industries*, January 13th issue :—

"It may be a certain sign of the rapid development of electrical engineering that so many books on electricity in its various bearings are published. If the books were generally good, this would be a pleasing feature, but though a few are valuable, the majority are—even when judged from a favourable point of view—very bad.

"The astonishing thing is, that the bad books seem to sell best. A book on electric lighting, say, is brought out. It has been written by some one who has neither a practical nor a theoretical acquaintance with his subject; it is reviewed in the various technical journals, which agree that it is absolutely worthless; and yet in a month or two the second and third editions are brought out. If there were no other books on the subject, one could imagine that even an indifferent book might have a good sale, but the booksellers' shelves groan with treatises on electric lighting. Who buys them, and why do readers squander their money in that way?

"These works come in for review in shoals. I let them collect for a short time until I have a clothes basket full, and then spend a miserable quarter of an hour reviewing them. They are all alike in having the same illustrations of obsolete machines and the same letterpress; the only difference is in the errors introduced.

"I sometimes feel guilty of unpardonable leniency in reviewing such books, but am generally inclined to deal lightly with any individual work, because the faults in any one particular book are generally less than the faults in all the rest of the basketful. Moreover, it is much easier to write a smart review than to write a good book, and this feeling generally engenders leniency, unless the reviewer is a sharp young man. Still, a reviewer's duty to the public is to state what he thinks of the books before him.

"There are several classes of electrical book. The first is the rarest. It is the good book, written by the competent author. It is so rare that it need not occupy attention just now.

"The second is the scrap-book. It is built up entirely of extracts from the technical press. It is generally made in Germany or in France, and is sent out with a paper back, so that it falls to pieces on its way through the post. It would have been much better to send out the book in the form of loose sheets like first proofs; it would then be more convenient to read, as it could be held like a newspaper, instead of like the tail of a kite. The scrap-book treatise might be very valuable if the collector understood his subject and chose the best cuttings. For instance, if the book is on dynamos it would be very useful to have a collection of the various articles that have been written on the subject by different dynamo specialists. The collector does not do this, however. If he has fifty papers on the theory of dynamos, of which forty-nine are nonsense, he leaves out the really good one because it looks too simple and has no complicated empirical formulæ, and inserts the other forty-nine. The collector then strings the whole forty-nine theories into one chapter if he is a Frenchman, and into one sentence if he is a German, without the least idea that each is absolutely contradictory of the other 48. If Strecker's *Fortschritte* did not exist, the scrap-book might be useful as a kind of reference index to the subject, but under existing circumstances it is not useful even for that purpose.

"The third class of book is more numerous. It comprises books of the 'Electric Light Popularly Explained' family. This is an easy book to write, and may be built up as follows :—You make a collection of ninepenny electrotypes of the Gramme ring, with a piece cut out to show the construction; the Alliance, and other early machines; the Serrin and Dubosc lamps; and any blocks that are at least ten years old. The letterpress should begin with descriptions of batteries, and should give the law of coupling cells so as to get the greatest output, and it is absolutely necessary to give this as the law of highest efficiency, largest current, or greatest electromotive force. It does not matter which of these errors is made, as long as one at least is introduced. The simplest method of writing the letterpress is to make a hash of the various similar books previously published, and to sprinkle sparsely with good grammar and copiously with original definitions of potential, and of the watt.

"The fourth class is the electrical pocket-book, and this forms an important class by itself. It is called a pocket-book because it will go into a shooting-coat pocket with a little force. It contains a large collection of information that no one could possibly want. Students buy it, not for use, but because they like to have a handsome and ponderous tome on their shelves. Sometimes they put it on a small table in the window, with an antimacassar under it and a flower pot on the top, as the British workman does his family Bible—when he has one. The pocket-book contains formulæ for coupling-up batteries; tangent formulæ, which are supposed to have something to do with dynamos; tables of the heats of combustion of various things that no electrician wants to remember; tables of logarithms, useless to people with slide rules; specific resistance of bricks, the human body, brass, vulcanised rubber, and gallium; the dimensions of units; the heating of electric light cables, with their insulation removed; the specific inductive capacity of glass, nitrogen iodide, and wax; the contact pressures of metals; a magnetic map of England; the Morse alphabet; and some spare pages on which the owner can write some useful formulæ himself without altering the design of the rest of the book. A useful book of formulæ is difficult to compile, for each engineer wants data that refer to his own particular business, or to his particular branch of that business. No dynamo designer, for instance, could make use of the formulæ given, and no one working at, say, thermo-electricity would take his data from a pocket-book.

"The fifth book I will ask your readers to consider is the treatise on alternate currents as they ought to be. This book is built up either of trigonometrical analyses or clock faces. It does not deal with real alternating currents at all, and is of no value whatever. There have been few more successful methods of spreading ignorance than the hypothetical treatment of alternating currents. One of the classical writers on phantom alternate currents owes his reputation in a large measure to an extensive set of researches on transformers, in which he brought out the loss in the iron considerably less than zero. His papers were mathematical, and therefore commanded the greatest respect. They were also nonsense, but that did not matter. Another authority on hypothetical alternate currents is said to have stated that if real machines did not give harmonic currents, it was time designers learned to make them do so. Another leading authority solemnly—and in all seriousness—discussed before a scientific society a

case in which n central stations, of which some supplied direct and the others alternate currents of various frequencies, were coupled together in parallel through $n + 1$ dynamometers. The dynamometers were apparently to measure the power each station delivered when short-circuited into the rest of the n stations. The elementary treatise on alternate currents is, however, now on the wane, and it may therefore do less harm in the future.

"Now I come to the sixth class, and this is made up as a text-book of electricity and magnetism, and is quite another matter to the foregoing. This book is a symptom of a very widespread educational disease. It begins about Thales and Electron, and devotes half its useless pages to descriptions of experiments on vitreous and resinous electricity. Each chapter has idiotic questions or examples at the end. The text-book is generally designed to suit the requirements of various examining bodies. The sameness of text-books on electricity is very remarkable. They all treat their subject in the same order and in the same way, and they all have the same illustrations. They generally assume ignorance of the elements of the calculus on the part of their readers, and give long and heavy proofs, which involve the methods of the calculus without appearing to do so. It would be far easier for the student to master enough of the calculus to tackle the subject in the proper way, than to follow one single demonstration of this kind. In the text-book it is assumed that engineers measure current with tangent or sine galvanometers; that they do not measure pressure at all, and that they make experiments with proof planes and dolls' heads. The criticism of the electrical text-book, however, is really somewhat out of my province at present. In fact, it is more a matter for educationalists rather than for those concerned with the industrial application of science.

"The great fault to be found in electrical books generally is that they are usually written by the wrong men. A book on electric light should be written by an experienced electric light engineer, not by someone who wants to found a reputation as an engineer on his book on the subject. Similarly, a book on dynamos should be written by a designer of dynamos, and so on. I do not quite know who should write the popular book on the applications of electricity to the welfare of people in general, but it certainly should not be entrusted to the inexperienced writer who thinks that a superficial knowledge on his part is sufficient to give the reader general information. Nothing is more difficult than to write a really good elementary popular book that shall be easily understood, and be scientifically correct. No man who cannot write an advanced treatise is able to write an elementary primer.

"As to the College text-book, presumably the lecturer who really teaches electricity should write it; but I doubt whether there is such a person. Certainly the teacher who is directly or indirectly concerned with examinations is never able to write a book which is to impart information.

"One word of advice to budding authors on electrical subjects, and I have done. Let me ask them, when tottering on the brink of authorship, to follow *Punch's* advice to those about to marry.

"Yours, &c.,

"A SADDENED REVIEWER.

"London, *January 10th*, 1893."

LEGAL.

THE THREE-WIRE SYSTEM.

JUDGMENT has been given in this case in favour of Dr. Hopkinson, the plaintiff.

Mr. Justice Romer, in delivering judgment on Saturday held that the plaintiff's patent was valid. The objections to the patent wholly failed.

THE CONSTRUCTION OF THE SPECIFICATION.

At the date of the patent there were two known systems of distributing electricity for the purpose of electric lighting to which the patent was practically directed. His Lordship was satisfied that the patent also extended to other uses of electricity where it was supplied at a fixed potential. The first question that arose in the cases before him was whether the plaintiff's specification was intended to extend to the series as well as the parallel. His Lordship held that it was restricted to the parallel. The parallel systems as known before the date of the patent were examined, and it was quite clear that the plaintiff's patent remedied the great drawbacks of the then known systems.

THE ANTICIPATIONS.

Three anticipations were relied on by the defendants. The Sauchiehall, the Alexandra Palace, and the Inchigore installations. If the defendants' case as to Sauchiehall had not broken down an anticipation would have been established. On the whole evidence he was satisfied that there was no anticipation, and that the installation at Sauchiehall was not the three-wire system at all but at most merely a case of the ordinary multiple parallel where the middle wire was not connected with the dynamos. There were two witnesses for the defendants, Andrews and Town, whose evidence on this point he could not accept.

With regard to the Alexandra Palace, it was merely a case of two arc lamps in series, with a common return between them to the dynamo. When both lamps were burning the electricity passed along the main conductor, and for all practical purposes no electricity passed down the return or central wire. There was no tapping and certainly no parallels.

As to the Inchigore case it was in principle not distinguishable from the Alexandra case.

Having shown that the objections of the defendants altogether failed he would grant to the plaintiff the usual relief sought by him against the defendants as infringers, with costs.

A certificate of the validity of the patent is given, and a certificate that the plaintiff had proved his breaches, and an account of the profits and delivery up of infringing apparatus. Costs were awarded on the higher scale.

The judgment, with the consent of the owners of the patent, has been suspended for six months.

DR. JOHN HOPKINSON *v.* THE ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

(*Continued from page* 712, vol. 31.)

JUDGMENT.

IN the Chancery Division of the High Court of Justice, on Saturday the 14th inst., Mr. Justice Romer gave judgment in this case.

HIS LORDSHIP said: The only point for decision in this case is whether the plaintiff's patent is valid, for if valid infringement is not denied. The decision upon this point depends upon certain questions not of law, but of electrical science, and in my opinion more suitable for the consideration of an expert in that science than of a legal tribunal. I have, however, been assisted by the evidence of skilled witnesses of the greatest distinction, and though unfortunately as it generally happens in patent cases the experts on the two sides do not agree, I have been enabled to come to a conclusion with regard to the objections taken to the patent, and that conclusion is that the objections fail and that the patent is valid. In dealing with these objections, I will first consider those taken to the second claim in the patent, being the claim which relates to the invention now known as the Three Wire System, and is the invention used by the defendants and in respect of which relief is sought in this action. On this part of the case it is of the utmost importance to understand what, according to the true construction of the specification, is the invention claimed by the patentee. And to understand the specification, which is a document of necessity addressed to and framed for the consideration of the small circle of persons acquainted with the difficult subject to which it refers, the following facts should be borne in mind At the date of the patent there were two known systems of distributing electricity for the purpose of electric lighting, to which the patent was practically directed. I am aware that, theoretically, and in its terms, the patent was not confined to the purposes of lighting, but extended to any purpose requiring the consumption of electricity in a system where the electricity is supplied at a fixed potential, but I am satisfied that this extension is of no practical importance for the purposes of my judgment. When it is remembered that consumers of electricity generally (such as motors) can only be used with the plaintiff's invention when the electricity is supplied at a fixed potential, and I shall accordingly hereafter only refer specifically to lighting, though it must be understood that I intend in my subsequent observations to include the more extended purpose of the patent, and where relevant and proper the necessary extensions of phrase to cover such extended purpose must be taken as intended, though for the sake of brevity and clearness I may speak only of electric lighting. The two systems I have referred to are in the evidence before me, and may properly be spoken of shortly as the

parallel and the series systems. These two systems differ in principle. In the parallel system of lighting, which chiefly concerns incandescent lamps (though arc lamps may be used, but with difficulty and not so usefully) the supply of electricity is at a fixed potential with varying current. The system derives its name from the parallel wires which tap the main service conductor along which the electricity flows from the dynamos and join the other main service conductor down which the electricity flows back to the dynamos. On these parallels the lamps are hung, and the current varies as more or less of these parallels are used for the purpose of lighting the lamps on them. In the series system, used chiefly for arc lights, the lamps are hung in series along the main conductor, and the supply of electricity is at a fixed current, while the potential varies as more or less lamps are burnt. The first question that arises in the cases before me is whether the invention I am now considering was by the specification intended and shown to extend to both systems, or to be restricted to the parallel system. For reasons which I will hereafter give when examining the specification in detail, I am satisfied that the claim was confined to the parallel system. And I may now shortly state what the invention was. Before the date of the patent, the parallel system was not only well known, but had been much improved from its first stage, which has been called the simple parallel. In the simple parallel there was no connection between the parallels except by the main conductors, and the consequence was that if one lighted lamp on any parallel had to be turned off, all the lamps on that parallel had also to be turned off. The improvement on this was called the compound or multiple parallel, and consisted in placing a wire which joined the middle points of the parallels so that on each parallel there occurred a lamp or lamps on each side of this intermediate wire. By this arrangement the lamp or lamps on each side of any parallel might be turned off and yet leave the lamp or lamps on the other side of that parallel still burning. But even this compound parallel system had a great defect—arising from the fact that the turning off of lamps from one side only of the middle wire had the effect of increasing the brightness of the lamps remaining burning on that side and diminishing the brightness of the lamps burning on the other side. So that in practice in a system of electric lighting lamps kept varying in brightness from time to time as other lamps on the system were turned off or on, and this fluctuation of the lamps was a considerable drawback to the use of the system, especially in private houses. The patentee discovered the means of remedying this by a contrivance as simple as it was useful. He joined the intermediate wire to the wire connecting the two dynamos working in series, and the thing was done; for it was found (speaking shortly and not with scientific accuracy) that the difference between the electricity used on the two sides of the middle wire which caused the difference of brightness under the old compound parallel system passed away down the central wire to the dynamos under the inventor's system and ceased to act as a disturbing element in the intensity of the burning lamps, and thus the brightness of the two sides was kept equalised and steady. The system so perfected and which, as I have said, is now generally spoken of as the three-wire system, was of great practical utility, and in lighting on a large scale permitted the main copper conductors to be comparatively small without risk of bursting lamps, thus effecting a considerable saving in copper (which was for practical work a great *desideratum*) and also a saving in the expenditure of electrical energy. The advantages of the discovery of course increased as more parallels and lamps were used and were of considerable practical importance in the case where several lamps and parallels were used and only became minimised when only two parallels were worked. I will now examine the specification in detail, in order to see that the contention on the part of the plaintiff is established that the claim in the patent is confined to the parallel system. Now it is true that throughout the patentee does not use the term "parallel" to define the system which he is dealing with. I believe this to be, because he preferred to use the appropriate scientific terms to describe the system rather than the popular term. But, in my opinion, when the specification is read with care and fairness, and well understood, it is clear that the patentee is thereby confining his claim to the parallel system. He shows throughout that he is dealing only with a system in which the potential is to be kept constant at the places where the electricity is to be supplied and in which the current varies as more electricity is required to be used on the different wires that tap the main conductor—that is to say, that he is dealing only with the parallel system—for on the balance of evidence it is clear that the characteristics I have named denote the parallel system, and only that system. At the commencement of the specification (page 3 of the print, lines 7 to 10), where he refers in general terms to his inventions, he shows that the system he is dealing with is one where the electromotive force is supplied at a fixed potential. Now that is a phrase well known to electricians (see *inter alia* evidence of defendants' witness, Mr. Swinburne, 7th day, pp. 35 and 36). Moreover, I think that the words "such conductors," at line 9, mean "conductors for an electric supply at a fixed potential." It is possible, however, that the words may mean merely "conductors for an electric supply," and I therefore pass on, only observing that the sentences immediately following (and in particular the phrases on lines 12 to 17 and 24 to 25), appear to me to support the view I have taken as to the meaning of the words "such conductors" in line 9. Then, at lines 9 and 10, and 31 to 38, the patentee describes what his invention is, and its special advantages substantially, as previously pointed out by me in this judgment. At line 9 and 31 he shows that one of the advantages is economising the cost of the main conductors, and I may add that the very expression "main conductors" implies branch conductors which do not really exist except on the parallel system. At line 9 to 10 he shows that this can be done "consistently with efficiency and safety," that is, as I understand it, with efficiency so as not to disturb the brilliancy of the lights and with safety, because on this system there was no risk of bursting the lamps by overpressure on any particular lamp. Then, at lines 35 to 38 he shows that the object and effect of his third wire is to bring back to the dynamos the excess of electricity required for the lamps on the one side of the central wire over that required for the lamps on the other side. I may now pass on to p. 5, line 32, where the patentee proceeds to describe in detail the particular invention I am now considering, merely remarking in passing the observations at p. 4, lines 44 to 53, as clearly referring to the parallel system. Now, the detailed description at p. 5, lines 32 to 48, when fairly read, in my opinion, shows clearly that the patentee was referring to the parallel system only—many of the expressions used, as well as fig. 5, being inapplicable to the series system. Then when I come to the second claim at p. 7, lines 7 to 21, being his claim in respect of the invention I am now considering, I find it clearly made with reference to his detailed description at p. 5, lines 32 to 48 and to fig. 5, which, as I have before said, in my opinion, refer to the parallel system only. Moreover, in a question of this kind depending, as it does, on what meaning electricians would attach to the technical phrases used in, and the wording of, the specification, I am entitled to take into consideration the views of the experts called as witnesses before me. With regard to this, I need only say that in my judgment on the balance of the evidence, which is to some extent conflicting, it establishes that the specification to an electrician would show that the parallel only is the one referred to by the patentee. But, indeed, on this point there is not so much difference as might be expected, as the defendants' experts generally admit that the patentee was thinking of the parallel system, though they are not agreed with the plaintiff's experts that he has with sufficient clearness in his specification confined his claim to that system. And some of the statements made by the defendants' experts are very significant as supporting the plaintiff's case—as, for instance, Mr. Swinburne 7th day at pp. 24, 25, 37 and 38. Having come to the above conclusion as to the meaning of the specification, I now proceed to consider the objections to the claim. The utility of the invention cannot be disputed, but it is said for the defendants, first, that the invention has been anticipated, and failing that, secondly, that having regard to the state of knowledge at the date of the patent there was no sufficient merit, discovery, or novelty to sustain or form the subject of a patent. As to the first objection, there are in substance three alleged anticipations relied on by the defendants—namely, those which may be shortly referred to as the Sauchiehall, the Alexandra Palace, and the Inchigore installations. A few others were referred to in the evidence, such as the installation on the ss. *City of Berlin*, but these did not substantially differ from the Alexandra Palace and Inchigore cases, and need not be separately considered by me. Now, if the defendants' case as to Sauchiehall had not broken down, an anticipation would have been established. But on the whole evidence as to this, I am satisfied there was no anticipation, and that the installation at Sauchiehall was not the plaintiff's three-wire system at all, but, at most, merely a case of the ordinary multiple parallel, where the middle wire is not connected with the dynamos. There were two witnesses for the defendants (Andrews and Town), whose testimony, if it could have been accepted, would have established that the third wire was connected with the dynamos. Sir Horace Davey, also, in his summing up, referred to a witness, McKillop; but in justice to that witness, I am bound to say that, taking his evidence as a whole, he did not purport to say from his own knowledge that the third wire was connected with the dynamos (see in particular his cross-examination, 6th day, at bottom of page 132). Now as to Andrews and Town, I am sorry to be obliged to say that I cannot give credit to their testimony on the point. This Sauchiehall case broke down and may be dismissed from further consideration. Then as to the Alexandra Palace case; that was in my opinion no anticipation. The following are the conclusions I come to from the evidence before me taken as a whole. This Alexandra Palace installation was not a case of the parallel system at all. It was merely a case of two arc lamps in series with a common return between them to the dynamo. When both lamps were burning, they were burnt in series on one main conductor, and the whole electric current went along the main conductor through the two lamps, and for all practical purposes no electricity passed down the return or central wire. When one lamp only was burnt the central wire (which was as thick as the main conductor) operated as part of the main conductor, and the electric current went along this one conductor only through the lamp back to the dynamos. There was no tapping and certainly there were no parallels. There was no saving of copper in the way and of the kind effected by the plaintiff's invention. The third wire was as I have already said, in fact, of the same thickness of copper as the main conductor, and such saving of copper as was effected was only such as is always obtained when a common return is used—that is to say, that instead of having four main conductors to burn two arc lamps separately, you have three only, because of the common return. The central wire cannot be said fairly to carry away excess of electricity—between lamps on one side and lamps on the other—within the meaning and spirit of the plaintiff's invention and specification. For all substantial purposes the central wire either took back the whole current or none. The practical advantages of the plaintiff's invention were not or were certainly not all obtained in this installation, and I think it is not a fair objection to the novelty of a process which is intended to be, and which is of great use when applied to a system comprising many things, to say that the case of one has not been expressly excluded by the inventor, and that as the application of the process to the case of the one so far as it could be applied to the one was known, therefore the process has been anticipated, though the utility of the invention practically disappears when the case of the one is considered. If such an objection were allowed there could never be a valid patent for many important discoveries, as for instance for many discoveries in connection with multiple telegraphy. Then as to the Inchigore case: that in principle is not distinguishable from and does not go beyond the Alexandra

Palace case. The only difference is that instead of one lamp on each side of the central wire there were several lamps. But the lamps were in series—the same number on each side—and, as before, either all the lamps were burnt in series on a main conductor, in which case substantially no current passed down the central wire, or one set of lamps was burnt in series, in which case, the central wire became part of the main conductor and substantially all the current flowed down it. In this case as in the Alexandra Palace case, one of the essentials of the plaintiff's system was absent, namely, the joining of the middle points of the bridges or parallels to one another. All the remarks I have made with regard to the Alexandra Palace case, in fact, apply to this, and I need not repeat them. It follows that the alleged anticipations fail. Then as to the second point—that there was no real invention made by the patentee. The case is put most strongly for the defendants in the following way. It is said that taking the Inchigore case you could easily turn the series lighting into parallel, and that to do this required no invention, and that if this were done you had the plaintiff's invention. It is also said that taking the known compound parallel system it required no invention merely to connect the third wire with the dynamo, especially as this had been done in the common return, and in the Alexandra Palace and Inchigore cases. But I think these views fallacious. No doubt now that the thing is done it is very easy to understand and becomes obvious to all. But I do not think that it was obvious until discovered, or that it could be arrived at without thought and experiment. An electrician who knew all that had been done up to the date of this patent, and who set himself down to try and cure the known defects of the existing compound parallel system, would by no means, as a matter of course, have hit upon the plaintiff's invention. In particular, I think that it would probably never have occurred to him to regard the Alexandra Palace and Inchigore installations, which were series systems, as being likely to lead to a solution of the problem or to try the effect of turning the Inchigore series lamps into lamps on parallel. Certainly, in my opinion, he could not have come to the conclusion that such an attempt would result in success without investigation and experiment, especially when it is borne in mind that the Alexandra Palace and Inchigore lamps would not have burnt in parallel. And a convincing proof that the plaintiff's discovery was not obvious lies in the fact that there were skilled electricians who at this time knew of the series and parallel systems, and some of them had about this time to put up installations on the parallel system in which it would have been of great advantage to use the plaintiff's invention, and yet it never occurred to any of these electricians to use it, and the invention remained undiscovered by them. Take for example the case of the defendants' witness, Mr. Crompton (fifth day, p. 16), who put up the Alexandra Palace installation, and of Mr. Siemens, who put up the Inchigore installation. The fact is, that electricians knowing the compound parallel system and having the Alexandra Palace and Inchigore installations before them, were on the verge of making the plaintiff's discovery and yet though they were all eagerly searching for novelties and improvements, they never made it. And it is a significant fact that Prof. Silvanus Thompson (one of the defendants' witnesses) for the purposes of a lecture, about this time prepared a diagram showing all the principal and newest systems or methods of lighting which were known or occurred to him, and yet it never occurred to him to suggest a system like the plaintiff's (see exhibit S. P. T. 1). For these reasons I think the second objection fails, and I have thus dealt with the principal objections to the patent. But there are one or two minor points taken on behalf of the defendants with which I must now shortly deal. It is said that the plaintiff's specification is insufficient, inasmuch as the patentee says his system is applicable to the case of alternate currents, and the defendants allege that to work dynamos in series with alternating currents, they must be rigidly coupled, and that a workman is not told by the specification to rigidly couple the dynamos, and would not know that he ought to do so. Now on this point there is considerable conflict of evidence, but on the whole I am satisfied that the objection is not substantiated. I think that any workman of ordinary skill who would be employed to put up the dynamos to be used according to plaintiff's specification, would know that the dynamos to be worked in series with alternating currents must keep time, and that the ordinary method of effecting this would be rigidly coupling the dynamos. The fact is that for many years prior to the patent the dynamos had been rigidly coupled in practice, and at the date of the patent it was a somewhat novel discovery that, as an exception to the general rule, rigid coupling might be dispensed with when the dynamos were not in series. I need only add that a portion of Lord Kelvin's evidence on this point, third day, at page 33, relied upon by defendants' counsel, has, I think, been misunderstood. I think Lord Kelvin was there considering the case of an ordinary workman with no experience or knowledge as to dynamos. I do not think he meant to suggest that a workman of ordinary skill—such a man as would naturally be employed in putting up dynamos—would have experienced any doubt or difficulty in putting up dynamos so as to make them work efficiently in series with alternating currents. But if he did, then I think, on the balance of evidence as a whole, that he was mistaken in this part of his testimony. The above substantially exhausts all the objections taken to the plaintiff's invention that is the subject of this action. But the defendants say the plaintiff's first claim, which concerns what I may call the potential measuring machine, is bad, and so the plaintiff's patent must altogether fail, even though the second claim, by itself, would be good. But the defendants have failed to satisfy me that the first claim is bad. In the first place they say the invention claimed is not useful. On the balance of the evidence before me, I am satisfied it is a useful invention, and can be used to advantage, though, owing to a variety of circumstances, it may not have been used commercially in its simple form as described in the patent up to the present time. The defendants' only other objection to this first claim is based on the allegation that the machine will not work as a practical machine with alternating currents, owing to locally induced currents thereby caused. On the balance of the evidence before me, I am satisfied that it will work. I think, moreover, the specimen of this machine made for the plaintiff was fairly made according to the specification, and that specimen certainly worked well. No doubt, if you are perversely ingenious enough to sit down and see how you can make a machine which, though nominally in accordance with the plaintiff's invention, yet will not work, you may succeed. The model produced by defendants shows this; but that model I do not regard as fairly made in accordance with the plaintiff's invention and specification. Having now dealt with all the objections against the plaintiff's patent urged before me, and shown that in my judgment they fail, I grant to the plaintiff the usual relief sought by him against the defendants as infringers, with costs.

Mr. ASTON, Q.C., asked for a certificate of the validity of the patent in question, and a certificate that the plaintiff had proved his breaches.

Mr. JUSTICE ROMER: Yes.

Mr. ASTON asked, secondly, for an account of profits and delivery up of infringing apparatus.

Mr. JUSTICE ROMER: Yes.

Mr. ASTON then applied for costs on the higher scale, saying that if ever there was a case in which that scale should be allowed, this was it.

Mr. JUSTICE ROMER intimated that he did not see his way to do that.

Mr. ASTON asked if the rule regarding costs on the higher scale did not apply to this case, in what case could the Court possibly be asked for such costs. It was necessary here to have not only men who were skilled, but men who were eminently experienced in the particular art which had been the subject of inquiry, and that art was of the highest kind. The questions for the Court were of the most delicate nature, and the plaintiffs had to do two things—to make out his case before the Court, and answer the very serious attack made on him by the other side.

Mr. JUSTICE ROMER said perhaps Sir Horace Davey would not object, because the case might possibly go elsewhere.

Sir HORACE DAVEY: That is not certain—I do object. (Laughter.)

Mr. ASTON said that with regard to costs, there was this point to which he ought to call attention. During the proceedings, notice was given on November 10th by the solicitor for the defendants to the solicitor for the plaintiff that another case of prior user would be brought forward. And a very serious case of prior user that would have been had it been brought forward on good evidence. The plaintiff was only allowed costs technically with reference to the cases that were in the particulars, and in this case, on November 10th, the plaintiffs were told that the defendants would apply to amend their particulars, and no doubt that application would have been made had the defendants thought that course advisable.

Sir HORACE DAVEY said his Lordship allowed the particulars to be amended.

Mr. ASTON said that was very true, but it was the second case which had escaped his learned friend's recollection. On November 10th the solicitors wrote, saying that they had only that day received information of another anticipation of the three-wire system which took place at Glasgow in 1881, in which case two Burgin dynamos were employed in series to apply the circuits of incandescent lamps on the three-wire system at the Art Gallery at Glasgow. The plaintiff had to make inquiries, and he did make inquiries, which incurred expense.

Mr. JUSTICE ROMER said the plaintiff would get any costs properly incurred.

Sir HORACE DAVEY objected to the costs in question being specifically included.

Mr. JUSTICE ROMER said that any costs the Taxing Master thought were properly incurred by the plaintiff would be allowed, but the costs in question could not form the subject of a separate order.

Mr. ASTON said that would satisfy the plaintiff.

Sir HORACE DAVEY, on the question of costs on the higher scale, said that on that point the Court of Appeal had taken a very strong view. So far as his limited experience went, he was not aware of any case where the Court of Appeal allowed them. So far as the practice of the Court of Appeal was a guide to the Court of first instance, that might be taken into consideration.

Mr JUSTICE ROMER said it did strike him that this was a case of exceptional gravity and difficulty, and a case more for experts than a legal tribunal, requiring witnesses of a special class.

Sir HORACE DAVEY said that that would apply to almost any patent case before the Court.

Mr. JUSTICE ROMER: No, no; I have never allowed them before.

Sir HORACE DAVEY said that in an electrical patent case (the Lane-Fox case) which lasted a fortnight before Mr. Justice A. L. Smith, in his Lordship's (Mr. Justice Romer) absence, the costs were not allowed on the higher scale. It was, however, so much a matter for the discretion of the Court, that he did not think it right to make it a matter of serious argument. According to his conception of the practice, he hardly knew any case in which it was done. He thought that in the Edison case they were not allowed.

Mr. ASTON believed they were allowed in the Edison case, and he knew they were in the telephone case and in the Otto steel case.

Mr. JUSTICE ROMER: There is the order, and I am bound to say that if ever there was a case in which the costs should be higher it is this. If I do not allow them in this case, I do not know any case where they should be allowed. I will make an order for costs on the higher scale.

Mr. ASTON applied, then, for the costs of the shorthand notes, pointing out the assistance rendered thereby to the Court.

Sir HORACE DAVEY said it had been agreed at the outset that each side should bear half such costs, otherwise, of course, they would be costs in the action.

Mr. ASTON could not fully accept that, but

Mr. JUSTICE ROMER said that under the circumstances he would make no order.

Sir HORACE DAVEY then applied for a suspension of the operation of the injunction, saying that his clients were an electric lighting company lighting a large portion of London where light was a necessary of life.

Mr. ASTON said that any facilities which ought to be given by the plaintiff should be afforded.

Mr. JUSTICE ROMER said he would suspend the injunction for a time.

Mr. ASTON said of course the account of profits would go on.

Mr. JUSTICE ROMER: Yes.

Mr. ASTON suggested that injunction should be suspended for six months.

Mr. JUSTICE ROMER thought that reasonable.

Sir HORACE DAVEY asked that the account of profits might be limited to the time when the specification was amended. *Prima facie*, he said, the patent was not good until it was amended, what was struck out by amendment being of doubtful utility and novelty; it must be assumed that up to that time there was no patent which could be enforced before the Court.

Mr. HOPKINSON, Q.C., pointed out that the defendants had admitted that the specification had been framed with reasonable care and in good faith.

Mr. JUSTICE ROMER thought this would be the best way. If the defendants were satisfied on further consideration that they had admitted what Dr. Hopkinson had said was accurate, there would be no limit of the time for taking the account; if not, the case could be restored to be mentioned on that point.

Mr. HOPKINSON, Q.C., read a passage from the evidence of Dr. Hopkinson on the second day to the effect that the latter brought reasonable skill and care to bear in framing the specification.

Mr. JUSTICE ROMER asked if there were any cross-examination.

Sir HORACE DAVEY: No.

Mr. JUSTICE ROMER thought there was evidence that the specification was framed in good faith, and with reasonable skill and knowledge.

Sir HORACE DAVEY supposed that "profits by the use of the three-wire system" meant the extra profits they had derived from the use of the three-wire system.

Mr. JUSTICE ROMER said they need not go into that.

Sir HORACE DAVEY said his learned friend had said something about delivery up of the infringing apparatus. Did he mean that the whole system of wires should be delivered up?

Mr. ASTON said he would be sorry to define what should be delivered up.

Mr. JUSTICE ROMER said he should not like to make an order which would cover all the dynamos. Might he suggest to the plaintiff that he would not press this part of the case.

Mr. ASTON: Will your Lordship allow us to consider it?

Mr. JUSTICE ROMER: Yes.

Sir HORACE DAVEY asked to be allowed to make this observation, which he was sure Mr. Aston would appreciate. The only thing the defendants had to do was to disconnect the third wire from the dynamo.

Mr. ASTON said that the Court knew that when there was an expression of opinion from the learned judge it enabled the parties to settle, and after what had fallen from his Lordship he was sure that nothing would be done that was harsher than was warrantable.

Mr. JUSTICE ROMER said learned counsel for the plaintiff had better consult with their client.

Sir HORACE DAVEY said perhaps the other side would communicate with them. It was rather a special case, and if the parties were unable to agree as to the form of the order, perhaps his Lordship would allow them to mention it again.

Mr. JUSTICE ROMER then directed that the case should be restored to the paper if there was any question as to the delivery order for directions on that point.

Judgment was accordingly entered for the plaintiff, with costs on the higher scale.

NATIONAL TELEPHONE COMPANY *v.* GRAFF-BAKER.

High Court of Justice.—Chancery Division.

(Before Mr. Justice Kekewich.)

(*Continued from page* 44.)

FOURTH DAY.—JANUARY 12th, 1893.

Upon the resumption of the hearing of this case after the holidays, Mr. JUSTICE KEKEWICH said he communicated with Mr. Macrory, and left him to make his own arrangements with both parties. Mr. Macrory had sent him a report, but he had already told Mr. Warmington that he did not intend to read it. He had also suggested that Mr. Macrory should tell his own story in the witness-box, but should not be sworn.

Sir RICHARD WEBSTER said it had been Mr. Justice Pearson's practice to have the report read by one of the counsel, and then if any questions were desired to be put to him they were put through the Court. As far as he was concerned, he should like the report to be read, because it would materially shorten his cross-examination. He suggested that, in accordance with the practice with which his Lordship was thoroughly well acquainted, it would not be convenient if referees were treated as witnesses.

Mr. JUSTICE KEKEWICH: I do not treat Mr. Macrory as a referee in the strict sense of the word. He is a gentleman sent down to assist the Court. He has no power to decide.

Sir RICHARD WEBSTER: I use the word referee in that sense only.

Mr. JUSTICE KEKEWICH: I think that is the proper course. Mr. Macrory will read his report if requested, and then questions will be asked, but he will not be treated as a witness.

Sir RICHARD WEBSTER, in accordance with subsequent arrangement, then read the report of Mr. Macrory, which was in the following terms: "In pursuance of the direction of Mr. Justice Kekewich, dated December 19th, 1892, that, with the co-operation of both parties, I was at Leeds to ascertain, by personal observation, how far, if at all, the plaintiffs' telephone system has been interfered with by the works of the defendant; that one person on each side was to be at liberty to attend me and offer observations; and further, that I was to be at liberty to employ any independent persons whom I might think necessary for the purpose of assisting me in such matters as testing the facilities for hearing sound at particular points, I, assisted by Mr. Henry H. Cunynghame, barrister-at-law (whom I employed in pursuance of the above directions to assist me), and attended by Mr. W. H. Winterbotham, solicitor, on behalf of the plaintiffs, and Mr. Swinburne, C.E., on behalf of the defendant, at Leeds, on Friday the 6th, and Saturday, the 7th inst., made a considerable number of experiments in almost every one of the cases alleged by the plaintiffs in their particulars to be disturbed, to enable me to test the telephonic system of the plaintiffs at various points in Leeds and the neighbourhood, where the telephone lines of the plaintiffs, or parts thereof, are in proximity to the tramway and conducting wires of the defendants. These experiments were made both when the tramcars of the defendant were running, and also when they were at rest, and in some instances the tramcars having been running when the telephonic communication was commenced, ceased to run while such communication was being made, and recommenced running before the said communication was concluded. In addition to the beforementioned experiments, the running of the defendants' tramcars was entirely stopped on Saturday morning from 11 o'clock until half-past 12 o'clock, during which cessation many of the experiments made on Friday and Saturday while the tramcars were running were repeated, and again, after the tramcars resumed working on Saturday afternoon, experiments made during the cessation of running were also repeated. The telephones used were in good order, and additional receiving telephones were switched in at the station in order to enable a number of listeners to hearken at the same time. During my experiments there was a coating of snow over parts of the tramline, which it was suggested might increase the disturbance on the telephone wires. I, however, saw no grounds for adopting this view. The experiments were made at 21 out of the 24 cases of alleged disturbance mentioned in the plaintiffs' particulars and shown on the map signed by me, and accompanying this report, which map was furnished me by the plaintiffs' solicitor. Most of these experiments were duplicated, that is to say, were made when the tramcars were running and repeated when the tramcars had stopped. In the first experiments Mr. Cunynghame and I, with Mr. Winterbotham and Mr. Swinburne, Mr. Leighton and Mr. Dalzell (the plaintiffs' manager at Leeds), were together at the Leeds Exchange, and telephoned to the attendant at the Roundhay call office and also to Sir James Kitson. The noise of the tramcars interfered very much with our hearing what was replied, and evidently interfered with the respondents hearing our messages. The noise occasioned by the running of the tramcars was easy to recognise. It was a whirring sound like that made by a card when held against the teeth of a rapidly-rotating cogwheel. Sometimes it was uniform like the rushing of water from a tap, sometimes it assumed a musical note rising and falling like the sighing of the wind among the trees. It was sometimes for a short time quite silent—I presume when the tramcar had stopped. After having tested from the Leeds Exchange, we tested all the places we were requested to test from the Chapel Town exchange and also from the Roundhay call office, and found the disturbance such as to interfere with our hearing messages when the tramcars were running, the disturbance varying much in its extent from time to time. We then separated, Mr. Cunynghame and Mr. Leighton going to one end of the wires, while Mr. Winterbotham, Mr. Swinburne, and I went to the other end at several places upon the lines of telephonic communication indicated on the map, and at each of the places we tested we found a similar result to what we found, as above-mentioned, at the Leeds exchange, the Chapel Town exchange, and the Roundhay call-office. A very remarkable test was made from the telephone at Dr. Jessop's, Roundhay Mount. Here, after communicating with Mr. Cunynghame at the Chapel Town exchange, and thoroughly testing the effect of the tramcars upon the telephones, both when the cars were running and when they were stopped, the telephone was put through to the office of the plaintiffs, Oxford Court, London, the course of the wire being from Dr. Jessop's to Chapel Town exchange, thence to Leeds exchange, from whence the wire proceeds through Manchester to London. This experiment was first made at 12 o'clock on Saturday. Mr. Winterbotham's voice was recognised in Oxford Court by Mr. Sinclair, and Mr. Sinclair's voice was recognised by Mr. Winterbotham, neither of those gentlemen being otherwise aware of the other at the respective ends of the wire. Mr. Swinburne afterwards held a long conversation on scientific matters with Mr. Sinclair. This took place while the tramcars were stopped, and I heard the conversation through a telephone receiver switched in for the purpose. The same experiment was repeated after the tramcars recommenced running, and while the tramcar was in motion it was impossible to hear conversation, but in the intervals of stoppage the voice came out quite clearly, like the sun emerging from behind a cloud, again becoming inaudible as the tramcar began to run. A similar experiment was made in conversing through to Blackburn, and with similar results. By means of the above, and other experiments of a like nature, I was enabled to form a decided and accurate judgment on the question put to me as above, upon

which I report as follows:—That the plaintiffs' telephonic system is seriously interfered with by the works of the defendant. In some cases the disturbance is so great as to render speech quite inaudible. By inaudible, I mean that though the sound of the speaker's voice may be heard, the words being transmitted are entirely unintelligible. In other cases speech was to some extent audible, but an effort on the part of the listener was required to distinguish the words being transmitted, and there cannot be a doubt but that the effect produced by the working of the defendant's tramcars and line is such as to greatly interfere with the efficiency of the telephone by creating noise, which in all cases impairs, and in some cases entirely destroys, the power of transmitting speech."

Mr. JUSTICE KEKEWICH: If either of you wish to ask any questions, you will consider them as put through the Court, but as a matter of fact, let them be put by the counsel, as being more convenient.

Mr. EDMUND MACRORY, Q.C., was then called, and, questioned by Mr. BOUSFIELD as to whether the remark in his report that he saw no ground for adopting the view that the presence of snow increased the disturbance on the telephone lines did not rather involve inferences of theory than of fact? said: It occurred in this way. Mr. Leighton called my attention to it, and said to me, "I should like you to make a note in your report that there was snow on the line at the time," which, he said, might increase or diminish the disturbance. I asked him in what way, and he suggested that it broke the contact between the wheel and the line of the tramway through which their return is made, and I certainly did see corruscations of light from the make and break that was going on when the tramcar started; but I thought it made no difference, because the experiment was made both when the tram-car was running and when it was stopped under the similar circumstances.

Sir RICHARD WEBSTER: The snow was there all the time?—Exactly. I thought, as Mr. Leighton asked that some reference should be made in the report, that I ought to make it.

Mr. BOUSFIELD: On the Friday there was practically no snow?—You are quite right. There was a very small coating of snow. It began on the Friday night.

But on the Saturday there were several inches of snow?—Three or four inches of snow. I should tell you that the attendants of the tram line were brushing the snow off while we were there with a little apparatus that they have got. A small snow plough, or something of that sort.

Did you not find that your experiments on the Friday were more satisfactory than on the Saturday—that the hearing was better?—I did not see very much difference.

Do you not think it would have been more satisfactory if you omitted those words, "I, however, saw no grounds for adopting this view;" which really trench on theory?—No, I think my Lord ought to be told what the effect on my mind was.

It clearly does involve some consideration of facts, and judgment upon facts, not merely report of facts?—I merely wanted to state a fact. I did not want to theorise upon it at all. I merely wanted to state that, to the hearing, it made no difference. The experiments conducted on the Friday, and those on the Saturday, were not so different in degree as to cause me to think that the presence of the snow had any injurious effect upon the tram.

Did you not think that the presence of snow would introduce an altogether exceptional and novel factor, which differentiated it from the ordinary conditions of the working of the line?—I do not think so. I would not have alluded to the fact of the snow at all if Mr. Leighton had not wished me to do so.

Snow is a conductor?—Yes.

If it clogs upon the wheel partially, it would make a series of making and breaking contacts?—Yes.

That, of course, of itself, would tend to aggravate the disturbance?—That I leave with your scientific witnesses; but there was one thing that I was told at the time, that a woman getting out of the car, when she stepped on the road, got a slight shock. I do not think I ought to leave the witness-box without telling your Lordship how exceedingly candidly I was treated on both sides. The gentlemen on both sides withheld nothing from me, and they made no observations during the whole time in any wise to interfere with my judgment.

Mr. BOUSFIELD once more suggested that the words referring to the snow should be struck out, but

Mr. JUSTICE KEKEWICH said: Whatever he thinks, I shall not allow it to be expunged. It is part of the report, and I cannot treat as not reported what has been reported.

Mr. JAMES SWINBURNE was then recalled, and cross-examined by Sir RICHARD WEBSTER, who first directed his attention to the evidence of Dr. Hopkinson regarding the disturbances in the telephones, and afterwards to his own evidence upon the same subject, finally asking him if he adhered to the opinion that there was no substantial interference with the commercial utility of the telephone.

WITNESS: I hold that opinion as regards the disturbances I heard the first time I went there, but I must certainly admit the disturbance, both on Friday, and especially on Saturday last, struck me rather the other way. I should certainly admit, as regards t ose, that the disturbance was very serious.

As regards Friday, you have no abnormal cause to suggest?—I think the snow had some effect.

There was no snow on Friday?—Yes, there was.

I must put what I am informed. With regard to the earlier part, considerably the major part, of the experiment on Friday, do you suggest any abnormal cause?—I suggest the snow.

When did it begin?—I do not know. I think it began before we got to Leeds. I did not notice.

Of course, the experiments were made continuously when the tramcar was running, and when it was not, the snow going on all the time?—Certainly.

May I take it that it was in May of last year that you first examined into the matter?—I have only examined it once until last Friday, and that was in May last.

Apart from that, have you, in fact, yourself installed any electrical tramway?—Not on my own account. I have been connected with them professionally. I was engineer to Messrs. Crompton at the time they had to do with the Elieson tram at Bow.

I wish to know whether you say to my Lord that you had, as an electrical expert, superintended personally the installation of any tramway at all?—No, I had not.

Your opinion is given upon your general electrical experience?—Chiefly.

You have stated that with regard to double overhead wires there would be a practical difficulty when you came to what you call a complicated junction. First, I desire to ask, does the present tramway of the defendant go through any complicated junction?—No; it has a Y joint, that is all.

Is it not the fact that if you were to take your tramway into Leeds to any of the places which you have called complicated junctions, where there were either three or four lines diverging, or a T-head crossing, I will not say to the same extent, but the same difficulties would arise, or the same character of difficulties as you describe with reference to the double-wire system?—To a certain extent there would be difficulties. They would be very much greater with the double system, and they differ in kind to a certain extent, because the difficulty in crossing comes in with a double wire—difficulties which do not exist at all on the single-wire system.

I ask you, first, whether you will undertake, as an electrician, to say that they differ except in degree?—They differ both in degree and kind.

Will you kindly tell me how they differ in kind?—They differ in kind in having the difficulty of crossing two conductors of opposite polarity when you use double wire.

Did you hear the evidence given both by Mr. Massey and Sir Frederick Bramwell with regard to the motors running the same way whichever way the current went?—I think there was a discrepancy in the evidence about that; one was incorrect and the other was not. If I understood the evidence aright, I think Mr. Massey's evidence was correct.

Is there the slightest difficulty in so constructing the motor that it will make no difference whichever way the current runs?—No difficulty whatever.

Does that not entirely remove the particular difference in kind that you spoke of, due to the difference of polarity?—No, it is not a question of reversal of polarity in the motor which gives the trouble; it is the question of having a positive lead and a negative lead together, and arranging so that the trolley on the positive lead can follow its course, and the trolley on the negative lead follow its course, without bringing the two positive and negative leads into electrical connection, and without breaking the circuit of the motor.

With reference to bringing the two leads together, you would require to have for a short space, say a foot or 18 inches, a break of contact?—You can put it at 18 inches; it is a little more than that, say two feet.

Do you suggest to my lord that there is the slightest difficulty in carrying the trolley over a break of two feet?—I do. In certain cases there would be practically none: but in other cases—and these cases, I fear would be the most numerous—there would be difficulty, because these difficulties would chiefly arise where there are complicated crossings, that is to say, where there are curves in the line, and where there is probably heavy traffic.

Have you a single practical instance, that is to say, of actual working, which in the whole country you can point to where any such difficulty has arisen?—No, certainly not; because I take it that engineers have been wise enough to avoid that difficulty by not putting up the double system.

If you are right in your suggestion that this difficulty would be worse with an electrical tramcar at what you call a complicated junction, would it not arise with much greater force in a cable tram?—I see there are difficulties in crossing in a cable tram, but I do not see quite how they are on all fours.

Can you tell, my lord, the distance which a tramcar has to run without the traction of the cable in cable trams? Do you know that it amounts to 10, 15, and even 20 feet?—No, I do not. I have no experience on the point.

You have spoken to the necessity where underground leads are used of an inch and a-half width of opening. Is the inch and a-half given on any practical knowledge or any personal knowledge?—It is not on personal knowledge, but I think there is a misunderstanding if you take it I suggested that an inch and a-half was necessary. I know electric tramways can be run under an inch and a-half.

I will call my Lord's attention to the particular answer, in which you say an inch and a-half opening would not be tolerated in Leeds, and the only connection in which you mention it is that it would be necessary, otherwise I do not understand the point.—The point of the evidence is that an inch and a-half was what was used at Buda Pesth, which was put to me. It was in answer to questions where it was suggested to his Lordship, I take it, that the Buda Pesth system might be applied easily to Leeds. The Buda Pesth system is made with an exceedingly large slot, for electrical convenience. It is perfectly well known to electrical engineers that an inch and a-quarter slot is the usual slot to use in a conduit.

Do you not know perfectly well that underground continuous tramways work perfectly well with a $\frac{3}{4}$-inch slot?—I know that in America electrical tramways have been made with a $\frac{3}{4}$-inch slot. I believe that is the standard size in America, but I do not know that they work perfectly.

Do not go to America. A little nearer home. Are you aware that the slot or opening at Blackpool is only a $\frac{3}{4}$-inch opening?—I was not aware.

Do you know that the electrical tramway at Blackpool, with an underground conduit, has been running for some years?—I know it has.

Now, when you came to give my Lord evidence about this slot, whatever you meant by it, had you taken the pains to enquire what the Blackpool slot was?—I should have guessed it at $\frac{5}{8}$ths.

Assuming that a $\frac{5}{8}$-inch slot is used, these particular disasters which arise from an inch and a-quarter slot would be removed?—No particular disasters do arise from an inch and a-quarter slot. It is a question of degree. The larger the slot, the more convenient it is, electrically, for the tramway, and the more inconvenient it is for the town.

The only difference with regard to the slot is that, at Blackpool, it is a single wire, is it not?—It is the Holroyd-Smith system there; I think it is a single wire.

Is it not a fact perfectly well known and recognised by electricians that you can use the same slot for a double underground conductor, putting the one above the other? It makes no difference to the size of the slot whether you have one conductor or two below?—No, except that it makes difficulty in the plough.

From the point of view of size of slot, it would not be disastrous to Leeds?—If you put a $\frac{5}{8}$-inch slot, I think, if I may put it as high, it would be disastrous, but disastrous to the tramway. If you put an inch and a quarter slot it would be disastrous to the town. It is a question of compromise.

It is not on practical working that you say it is disastrous to the tramway?—Not my own practical experience, but I cannot admit it is not a practical working.

Are you aware that a $\frac{5}{8}$-inch slot is less than an ordinary tram-wheel slot? Do you know what an ordinary tram-wheel slot is?—It is a round-cornered thing. Certainly, I should say it is more than $\frac{5}{8}$-inch; it is a rounded channel.

Do you know that the cable slots are none of them under an inch?—I cannot remember exactly what the cable slot on Highgate Hill is.

Have you examined any underground conduit electrically working at all?—I am not sure that I have even seen one.

You knew that the Northfleet tramway was put up, not as a commercial concern, but in order to demonstrate the practical working of this underground culvert system?—I believe so. I believe it was put up by some syndicate.

With full consideration and knowledge of what Sir Frederick Bramwell said, and your own electrical experience, will you suggest a single practical reason why the Northfleet system should not work perfectly well?—The first practical reason is, the contact-pieces went wrong in that tramway. It was a series tramway, with a curious arrangement for obtaining circuit through the dynamo.

The question of series working has nothing to do with the question I am upon, but probably I ought to have excluded that. Speaking of that circuit as it would be applied to motors in individual cars and series working, I ask you whether, after all your consideration, you can suggest any practical difficulty to the working of that system?—By "system," do you refer particularly to simply using the culvert?

I refer to the underground, with slot in one rail, or slot in two rails, if you like, taking up the current from an underground culvert?—There is the same objection that there is in all these underground culvert systems, the objection of the plough getting caught, the plough wearing through its insulation, and the leakage difficulties. Then there is the difficulty of cleaning out, and capital expenditure, of course. Another difficulty is the difficulty of switching, and that sort of thing.

Did you not mean to suggest in your evidence about Buda Pesth that the reason why the tramway could be used at Buda Pesth and not at Leeds was that at Buda Pesth it went along the Boulevards, that is, along streets where there would not be complicated junctions and much traffic, and at Leeds the contrary was the case?—I did mean to suggest that.

Will you undertake to say, and I ask you to answer my question a little carefully, if you know that there are not at Buda Pesth junctions and crossings practically of the same kind as those that occur in Leeds?—Which would occur, or do occur?

Which do occur in Leeds?—There are no junctions or crossings of importance at Leeds yet.

Are there not in Buda Pesth junctions where, to a greater or less extent, the same difficulties occur as would have arisen at the points in the complicated crossing in Leeds, of which you have shown a model?—I have not been to Buda Pesth, but I will say this, that I should be exceedingly surprised if there were any.

Have you any knowledge of what crossings there are at Vevey?—I have not been to Vevey; I only know of Vevey.

Now we will come to the cleaning out. You have heard Dr. Hopkinson's evidence with regard to what he called the drainage of the culvert. Do you suggest that there is any practical difficulty in keeping an underground culvert clear of water?—Clear of water, but not clear of mud.

I was a little surprised at your evidence about snow this morning. The snow would only affect the contact between the rail and the wheel and that between the trolley and the wire?—Chiefly between the rail and the wheel. I do not think it would make much difference unless it had been frozen hard after the snow.

In your evidence-in-chief, you said you did not think the variations in those contacts had any substantial effect. The greater or less amount of snow would only affect those contacts?—Yes. I may say the character of the disturbance on Friday and Saturday was different. The humming of the motors was there, but superposed on that was a sort of continuous noise, like the opening of a water-tap, and that struck me as being due to the varying contact of the wheels.

(To be continued.)

NOTES.

The Gadot Accumulators.—In consequence of a recent lawsuit, in which M. Gadot lost the day, he has entered into an arrangement with the French Electric Accumulator Company, by which he has obtained the right to manufacture and sell the Faure-Sellon-Volckmar accumulators. Under these conditions he still manufactures his own apparatus and constructs the others at the same time. But in the circular which he has just issued, he makes it appear that the Gadot accumulators are the best known and the most appreciated.

International Society of Electricians (Paris).—The last sitting of the International Society of Electricians took place on January 4th. M. Blondel led a discussion regarding the coupling in series and in parallel of alternators. He went into the various conditions of the problem, and also summed up the various articles published by him on the subject in *La Lumière Electrique*. A discussion followed between Messrs. P. Boucherot, Picou and Blondel.

Railway Train Electric Lighting in France.—Several attempts have already been made by the Paris Northern Railway Company to substitute electric lighting for the oil lamps now in use. After a few successful trials, fresh experiments have just been undertaken on a larger scale. Underneath each carriage were placed cases containing 16 accumulators, supplied by the Société des Métaux, each containing nine plates, the total weight of which is 8·1 kilogrammes. The total weight of the battery, including the cases placed under the carriages, is 390 kilogrammes. Each kilogramme of plates giving a capacity of 14 ampère-hours, we may reckon upon a total capacity of 115 ampère-hours. The lamps used are 10, 8, and 6-candle lamps; they require a difference of potential of 30 volts, with 3 watts per candle, and only last from 250 to 300 hours. For a first class carriage the cost of establishment amounts to 725 francs. This expenditure is made up as follows: accumulators, 462 francs; cases, 120 francs; cables, 65·8 francs, and fittings, 77·2 francs. The working expenses, comprising the renewal of the lamps, the charging current, the maintenance and manipulation of the accumulators, amount to ·0252 francs per lamp-hour of 16 candles. The expenses in connection with the interest and sinking of the capital are ·0048 francs per lamp-hour of 16 candles. Thus we have a total expenditure of ·03 francs per lamp-hour. At present, the oil lighting costs, all expenses included, ·038 francs per lamp-hour of 7 candles. Thus the company will effect a considerable saving.

Fire at the Popp Company's Station.—The working of this company is still attended with disasters, notwithstanding the changes that have been made. Frequently fresh accidents are reported. On December 30th a fire, which was fortunately not attended with serious consequences, occurred at the distributing station in the Rue Saint Augustin. A cable became heated and set fire to some pieces of wood.

Old Students' Association.—A meeting of this Association is to be held at the Central Institution, Exhibition Road, S.W., to-night, Friday, January 20th, at 8 p.m., when a paper will be read, entitled "Central Station Notes," by W. Brew and P. G. Ledger, members. The paper will be fully illustrated by optical lantern. The following is a synopsis of the paper:—Introductory. Boilers: Coal Consumption—Special steaming for short periods—Feed water—Specimens of boiler tubes from breakdowns. Engines: Continuous running—Efficiency—Direct coupling—Governors—Experimental results—Indicator cards. Dynamos: Parallel working with different types of machine—Lag of induction in large machines—Experimental results—Effects of form of characteristics on compound machines in parallel working. Switchboards: Instruments, &c.—Regulation—Practical and reliable standards—Supply: Theatres, &c.—Curves from Royal English Opera House—Motors in central station working.

A New Sector in Paris.—A fresh demand for an electrical sector in Paris was addressed to the Prefect of the Seine on January 4th.

The Société l'Eclairage Electrique Transformers.—In consequence of M. Leblanc's interesting researches the *Société l'Éclairage Electrique* has taken up the question of alternating currents. The engineer, M. Labour, has studied and has constructed a model of an iron transformer with a closed magnetic circuit. This transformer is definitely established for electromotive forces up to 20,000 volts, with frequencies above 40 periods per second. The powers are 2, 5, 7, 10, 20, 40, 60 and 100 kilowatts, as well as figures between these. The mean cost is ·102 fr. per watt.

Newcastle Electric Lighting.—A report made by the lamp inspector of Newcastle as to the lighting of London by electricity was considered last week by the City Lighting Committee. The opinion of the inspector was that the electric lighting of London was more satisfactory than that of Newcastle, and several suggestions were made in the document as to the alterations necessary to improve the present system of lighting in Newcastle both as to efficiency and cost. The report is to be printed and circulated among the members of the committee.

The *Newcastle Daily Chronicle* suggests that drinking fountains be fitted in the bases of some of the street electric lamp posts.

Southend Pier Electric Tramway.—The Southend Town Council have decided to purchase a duplicate engine, boiler, and dynamo in connection with the electric tramway on the Pier; but they have negatived a recommendation of the Pier Committee to also purchase a second lot of tramcars.

M. Cornelius Herz.—We (*l'Industrie Electrique*), have waged war often enough against M. Cornelius Herz when he was all-powerful, to be able to say a word now in protest against the rumours to the effect that he has attained to the highest honours in the order of the Legion of Honour for his scientific labours. When an author produces a good work, it is not usual to decorate the publisher who brings it out. The electrical work done by M. Cornelius Herz during the last 12 years has been that of a publisher of scientifico-industrial projects. His technical collaborateurs have been :—For the incandescence lamp burning in air : Werdermann, Napoli, and Reynier—all three now dead. For telephony : Messrs. Abdank-Abakanowicz, Paul Barbier, Kern, and Sieur. For the transport and distribution of energy : Cabanellas, Marcel Deprez, Frank Geraldy, Sarcia, and a long list of engineers connected with the now forgotten experiments of Creil-Paris. For the journal *La Lumière Electrique*, in its earlier days : Count Th. du Moncel, Gustave Cabanellas, M. Frank Géraldy, M. Hospitalier, Auguste Guerout, M. Marinovitch, M. Meylan, M. Palaz. If we compare the rewards given to these technical workers with those obtained by the business man who cleverly traded on their work, we shall arrive at the conclusion that in this century it is sometimes more advantageous, if not more honourable, to *sell* scientific knowledge than to *attain* it.

The Académie des Sciences.—Amongst the numerous prizes which have recently been awarded by this Society, the following are of interest to electricians :—Montyon (Mechanical) prize : M. N. J. Raffard, for his dynamometric balance and elastic coupling ; the former is an apparatus which can be employed with great advantage in the place of the Prony brake. The elastic coupling is stated to completely solve the problem of coupling two axles, end to end, which are not necessarily in the same straight line. Gay prize : M. Moureaux, the subject being, "A Study of Terrestrial Magnetism, and, in particular, the Magnetic Elements in France." Gaston Planté prize : The latter, which is to be awarded in 1893, is of 3,000 francs value, and is to be given for the most important discovery relating to electrical work.

Ilford Electric Lighting.—An expert representative of the Brush Electrical Engineering Company is to report regarding the question of electric lighting.

Bedford Electric Lighting.—A full meeting of the Town Council was to be held yesterday to discuss the electric lighting question.

Shoreditch Electric Lighting.—Mr. E. Manville has been retained by the vestry to report on certain points connected with electric lighting.

New Romney Electric Lighting.—An Electric Lighting Committee was appointed some time since, consisting of two members of the Town Council. These gentlemen asked for permission to spend £10 in making preliminary enquiries, and that three members might be added to the committee. Their requests were refused by the Council, and a new committee for considering the expediency of lighting the town by electricity has been appointed.

Coast Communication.—A meeting to consider the subject of electric communication with lightships was held at Ramsgate Town Hall last week, when a resolution calling upon the Government to establish an effective system of cable or telephonic communication between lightships and the shore, was passed.

Lectures.—Mr. Samuel Vyle, electrician to British Guiana, lectured at the Shoreditch Y.M.C.A., on Monday last, on "The Development of the Electric Telegraph." The lecture was illustrated by experiments.

A course of ten popular experimental lectures on "Pioneers of Electricity was commenced last Saturday by Principal Garnett in the Lecture Theatre of the Newcastle College of Science.

Prof. Silvanus Thompson lectured last Thursday at the London Institution on "Electric Lighting."

Last week Mr. James Bell lectured before the Dundee Mechanical Society on "Practical Telegraphy."

Falmouth Electric Lighting.—It is said that a report as to the introduction of electric lighting into the town is to be forthcoming shortly.

Brighton-Rottingdean Electric Railway.—The Bill for powers to construct an electric railway from Brighton to Rottingdean has been deposited for next Session. The promoters seek authorisation to construct a railway, just under three miles in length, commencing near the Paston Place Groyne, at Brighton, thence proceeding along the beach and foreshore, between high and low water mark, about 100 yards in front of the cliff, to its termination on the seashore at Rottingdean, where a pier or jetty is to be erected for a distance of 200 feet into the sea. The railway is to be constructed on the extraordinary gauge of 24 feet, while the platforms and carriages are to be "placed at such an elevation as to be safe from interruption by the sea." The capital of the proposed company is set down at only £15,000, with power to borrow a further sum of £5,000. The time sought within which to complete and open this railway is five years from the passing of the Bill, and from the clauses fixing the maximum rates and tolls, it appears that only passengers and small parcels will be carried.

Newbury Electric Lighting.—Messrs. Woodhouse and Rawson, United, Limited, have written to the Newbury corporation inquiring whether they would be disposed to sell to them the electric lighting provisional order, and the gas undertaking, and asking for terms. A committee had replied that the electric lighting order would be sold alone. The matter is to be further considered.

Shipley Electric Lighting.—The Shipley Tradesmen's Association in their annual report give utterance to the following, which may be taken as a recommendation to the Local Board, "Considering the poor quality of gas supplied and the high price charged for it, the Local Board would serve the interests of the ratepayers by adopting a system of electric lighting."

Kirkcaldy Electric Lighting.—The Brush Electrical Engineering Company have asked the local authorities whether they would sanction an application for an electric lighting provisional order.

Buda Pesth Electric Lighting.—It is stated that a financial group at Vienna is engaged upon the formation of a company for the purpose of lighting the Hungarian capital by electricity. The capital has been fixed at £250,000.

Redditch Electric Lighting.—An expert is to be engaged to advise regarding the electric lighting question.

Hammersmith Electric Lighting.—The electric lighting committee are considering the desirability of making experiments with a view, if possible, of using the refuse of the parish in generating electricity.

Dolgelly Electric Lighting.—Messrs. Hull & Co. have made application to the Local Board to grant an extension of time—from five years to forty years—to lay their electric wires. The matter has been adjourned until the council's next meeting.

Electrocution.—A man named Loth, who was convicted of murdering a woman, was executed by electricity at Dannemora Gaol, New York, on 16th inst. The apparatus is said to have worked more satisfactorily than ever before, death being instantaneous, and no mark being left on the body.

Taunton Electric Lighting.—At the meeting of the Taunton Town Council, last week, it was resolved to apply to the Local Government Board for permission to borrow £16,000, for the purchase of the electric light works and for the extension of the same.

Rothesay Electric Lighting.—The Electric Lighting Committee have received a full report from the engineers regarding the electric lighting, but are not yet in a position to make any recommendation upon it, as they were desirous of visiting some other places where installations have been adopted.

Physical Society of Glasgow University.—At the last ordinary meeting of this society, Mr. Magnus Maclean gave notes on some of the experiments performed in the physical laboratory by the students this session.

The Late Dr. Werner Von Siemens.—A memorial service was held on Monday last at Berlin in honour of the late Dr. Siemens. The German Empress was present.

Glasgow Electric Lighting.—It is proposed to make a trial next week, in Buchanan Street, of the electric lighting installation of the Glasgow Corporation.

Bradford Electric Lighting.—The Town Council have resolved to enlarge the area for electric lighting.

Hove Electric Lighting.—The transfer of the powers for the electric lighting of Hove from the Commissioners to the Hove Electric Lighting Company has now been accomplished. The progress of the electric lighting works is being pushed on as fast as the weather will permit.

Heckmondwike Electric Lighting.—A Local Board meeting was held on 16th inst., when it was resolved that Mr. Hutchinson, C.E., be appointed to prepare plans, specifications, &c., to promote the board's proposed scheme for lighting the town by electricity.

Life of Werner von Siemens.—An English translation of the "Recollections of the Life of the Late Werner von Siemens, is to be published shortly by Messrs. Asher & Co., of Bedford Street, Covent Garden. The German original, published in December last, ran most successfully through two editions in the course of a few weeks.

Heston Electric Lighting.—A committee has been appointed to consider the question of the bad gas lighting and its high price, and to also consider the desirability of supplying electric lighting for the Heston and Isleworth Local Board District.

Derry Electric Lighting.—It is stated that the plans for the lighting of Derry City, prepared by Mr. Blake, have been approved of by Dr. John Hopkinson, F.R.S., to whom they were submitted by the Derry Corporation.

The Institution of Electrical Engineers.—On Thursday next, January 26th, 1893, Mr. W. H. Preece, F.R.S., M.I.C.E. (President), will deliver his inaugural address.

Colombo Electric Lighting.—The *Ceylon Observer* gives particulars of an unsuccessful scheme to introduce the electric light into Colombo. It appears that some time ago a scheme was set on foot for lighting Government House, a number of the public offices, hotels, &c., there by means of the electric light; but the scheme has had to be abandoned. After the promoters had carefully gone into the question of cost and revenue, the decision they have come to is that there is not a sufficient margin to warrant carrying the scheme through.

Brushes for Dynamos.—The silvered copper wires, as well as the gauze, employed in the brushes have several inconveniences. On the other hand, carbon has not yet received a fair trial. A Paris manufacturer has constructed brushes formed of metal plates, from ·02 to ·03 millimetres thick, with a basis of copper. The plates are folded and placed one upon another, until the number is sufficient to attain the necessary thickness. These brushes are said to do away with sparks, and lessen the wear and tear of the commutator. Only experiments of long duration will enable the real value of these brushes to be determined.

New Municipal Electrical Works in Paris.—The Paris Municipal Council has certainly discovered that the Halles Electrical Works are not what was anticipated. They are underground, and badly ventilated. It is therefore proposed to establish another municipal station, by enlarging the works already existing, used for lighting the Park of Bultes-Chaumont, at La Villette, in Paris. These works contain a Brush dynamo, which serves to feed 20 arc lamps, from 8 to 10 ampères. It is proposed to construct a building above-ground, with every hygienic and electrical improvement. To arrive at a satisfactory result, it will be necessary to entrust this commission to a practical electrician who has already given proof of his ability.

NEW COMPANIES REGISTERED.

Gordon and Fell, Limited.—This company was registered on the 4th inst. with a capital of £100,000 in £10 shares, to acquire and take over as a going concern the business of J. E. H. Gordon & Co., electrical engineers, and the goodwill thereof; to carry on the business of a builder and contractor of public works, to prosecute in the United Kingdom and elsewhere, the business of electrical engineers, and to maintain electric light machinery and apparatus, both for public and private purposes. The subscribers (with one share each) are: C. Fairfax Crowder, Esq., Bromsgrove; T. F. Pountney, law stationer, Birmingham; H. A. Milward, tradesman, Redditch; J. H. Breakwell, accountant, King's Heath; T. H. Willday, insurance agent, Aston; J. Cobley; clerk, Birmingham; Wm. Tonks, accountant, Birmingham. The first directors are to be appointed by the subscribers to the memorandum of association, and their qualification and remuneration may from time to time be altered and fixed by the resolution of a general meeting. Registered by S. Whitehead, 188, Fleet Street, E.C.

Roger Dawson, Limited.—This company was registered on the 3rd inst. with a capital of £15,000 in 15,000 shares of £1 each, to acquire by purchase from A. R. Dawson, the business of an electric light engineer and contractor until

recently carried on by him in partnership with A. R. Phipps, under the style of Rashleigh, Phipps & Dawson, and now carried on by A. R. Dawson alone as sole owner; to enter into a certain agreement as specified in the memorandum of association, and to carry on in the United Kingdom or abroad, as may be determined by the directors for the time being, the businesses of civil, mechanical, or electrical engineers and contractors, including the manufacture, construction, purchase and sale of all kinds of machinery, or mechanical, hydraulic, pneumatic, or electrical appliances, and to prosecute all kinds of work involving engineering or electrical knowledge or supervision. The subscribers (with one share each) are: A. R. Dawson, electrical engineer, Weybridge; A. R. Cobbett, retired wine merchant, Addlestone; C. E. Tomlin, merchant, Streatham Park; F. H. P. Berlyn, electrical engineer, Brixton; P. J. Dawson, surveyor, Streatham Hill; A. Hicks, civil engineer, Streatham Hill; N. Hicks, law student, Lincoln's Inn. The number of directors is not to be less than two nor more than four. Article 65 of Table A applies to a permanent director. Registered by E. F. Hicks, 304, Lincolns Inn Fields, W.C.

Stephens & Co., Limited.—This company was registered on the 7th inst with a capital of £20,000 in £1 shares to acquire by purchase from John Stephens, of Cuba Street, Millwall, E., electrical engineer, &c., the freehold and leasehold land and buildings situate in Cuba Street, E., where he now carries on the business of electrical and general engineer, and, among other things, to prosecute the businesses of electricians, mechanical engineers, manufacturers and workers, and dealers in electric motive power and light, and any business in which the application of electricity, or any like power, is, or may be useful, convenient, or ornamental, and to manufacture and produce, and, either as principal or agent, trade and deal in any articles belonging to such trades as are mentioned above. The subscribers (with one share each) are: John Stephens, engineer, Cuba Street, Millwall; J. G. Statter, civil engineer, Westminster; L. Milne, civil engineer, Westminster; Hy. Foote, civil engineer, Westminster; W. J. Bromley, schoolmaster, Bow; J. H. Stephens, electrical engineer, Millwall; H. H. Stephens, Millwall. Mr. John Stephens is to be the managing director, and the board, irrespective of him, is not to consist of more than three. Qualification, £100. Remuneration to be determined by the company in general meeting. Registered by Close & Co., 23, Great Marlborough Street, W.

Waterhouse Electrical Manufacturing Company, Limited.—This company was registered on the 9th inst. with a capital of £20,000 in £10 shares, to adopt and carry a certain agreement into effect; to apply for purchase, or otherwise acquire, any patents or *brevets* of invention, for any invention, and to carry on or engage in any business that may be calculated to become profitable to the company. The subscribers (with one share each) are: Reginald Bolton, engineer, 110, Leadenhall Street; A. T. Salisbury-Jones, engineer, 33, Old Broad Street; J. J. Dale, gentleman, Hammersmith; G. J. R. Millington, engineer, Belvedere, Kent; F. W. Salisbury-Jones, mechanical engineer, 33, Old Broad Street, E.C.; C. F. King, gentleman, 42, Berners Street, W.; H. P. Arnhole, solicitor, 17, Great Winchester Street, E.C. The number of directors is not to be less than three nor more than five. Qualification £100. Registered by Russell and Arnhole, 17, Great Winchester Street, E.C.

Pyke, Harris & Company, Limited.—This company was registered on the 10th inst. with a capital of £30,000 in £5 shares, to take over as a going concern the business of electrical engineers, carried on by Messrs. Pyke & Harris; to work certain patents, and among other things to carry on the business of manufacturing, selling, and dealing in any chemicals, goods, or commodities of any description capable of being used to advantage. The subscribers (with one share each) are: W. J. Smith, accountant, South Hornsey, N.; H. J. Neale, clerk, Peckham; J. W. Jenner, clerk, Westminster; Thos. Lauder, manufacturer, East Sheen; J. Cunningham, shorthand writer, Pimlico; Jos. Mason, electrical engineer, 23, Commercial Road, E.; T. L. Walker, clerk, Clapham Junction, S.W. The number of directors is not to be more than five nor less than two; qualification, £200; remuneration, £100 per annum with certain percentage in the profits of the company. Registered by Fowler & Co., 28, Victoria Street, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cambridge Electric Supply Company, Limited.—The statutory return of this company, made up to September 28th, has been filed at Somerset House, and shows that out of a capital of £50,000 in £10 shares, 1,631 shares have been taken up, with £6 called on each. The result is £6,822. There is therefore £2,964 in arrears.

Carbon Electric Company, Limited.—The statutory return of this company, made up to November 25th, 1891, was filed on the 29th ult., and shows that out of a capital of £20,000 divided into 2,100 preference and 1,900 deferred shares, all of £5 each, seven shares have been taken up, and that no calls have been made. The company shows the same position from the first annual return, as the original signatories are still the only shareholders.

Chafford and Devon Electric Light Company, Limited.—The annual return of this company, made up to May 1st, 1892, shows that 724 shares have been taken up, of which 400 were issued as fully paid.

Charles Churchill and Company, Limited.—The annual return of this company, made up to the 13th ult., discloses the fact that, out of a nominal capital of £6,000 in 140 preference shares of £25 each and 50 ordinary shares of £50 each, 103 preference and 40 ordinary shares have been taken up, the greater part of which were issued as fully paid. The full amounts have been called upon the remaining preference shares, the result of which is £1,325.

Crossley Telephone Company, Limited.—The annual return of this company has been filed at Somerset House. The company was registered on July 11th, 1884, with a nominal capital of £100,000 in 5,000 "A" shares, 12,500 "B" shares, and 2,500 "C" shares, all of £5 each, to carry on the business of a motive power and generating company and analogous pursuits. On October 6th last, 607 "A," 120 "B," and 350 "C" shares were taken up, and £5,385, the full amount of all calls, paid.

Hove Electric Lighting Company, Limited.—The statement of this company has been made up to December 5th, and shows that out of a nominal capital of £40,000 in £5 shares, 1,667 shares have been taken up with £4 paid on each. The calls amount *in toto* to £6,645. There remains £124 unpaid.

"Electrician" Printing and Publishing Company, Limited.—The annual return of this company, made up to October 28th last, shows that out of a nominal capital of £10,000, in £10 shares, 940 shares have been taken up. There has been £10 called up on 140 of these, and the total amount of calls paid is encompassed in £1,400. The full sum agreed to be considered as paid on 800 shares is £8,000.

Electro-Metallurgical Company, Limited.—A meeting of the shareholders of this company was held on November 5th, for the purpose of having an account laid before them showing the manner in which the winding up of the company had been conducted, and the property of the company disposed of.

Electric Arms and Ammunition Company, Limited.—The annual return of this company, made up to the 13th inst., shows that out of a capital of £40,000 in £100 shares, £70 shares have been called up on each of 80 shares, resulting in a total of £5,540. There has been £21,000 agreed to be considered as paid on 210 shares, and £60 still remains outstanding.

County of London Electric Lighting Company, Limited.—The annual return of this company, made up to the 2nd ultimo, with a nominal capital of £100,000 in £5 shares, shows that 200 shares, with £2 called on each, have been taken up. The total amount of calls received is £400.

Central Electrical Company, Limited.—The registered office of this company is situated at 15, Union Court, Castle Street, Liverpool.

British Electric Propulsion and Traction Company, Limited.—The registered office of this Company is now situated at 50, Gresham-street, E.C.

Electric Inventions Company, Limited.—The official address of this company is 57, Moorgate Street, E.C.

CONTRACTS OPEN AND CLOSED.

OPEN.

Dusseldorf.— January 25th. For various materials, fittings, &c., for the Dusseldorf Gas, Water, and Electricity Works. Further particulars from the Director-General.

Kingston-on-Thames.—February 11th. For the construction, supply and laying down of the necessary plant and mains for the supply of electricity in the borough in accordance with specification. Further particulars will be found among our advertisements.

London.—January 21st. For the installation of wiring and fittings for the electric lighting (80 lamps) in a private house in the London suburbs. Further particulars from Mr. N. C. Darg, 19, Dashwood House, Old Broad Street, E.C.

CLOSED.

Belfast.—The tender of Messrs. Siemens Bros. & Co., has been accepted for the electric lighting of Queen's Quay, Abercorn Basin, and the Hamilton Graving Dock, Belfast, for the Harbour Commissioners.

BUSINESS NOTICES, &c.

Electric Launches.—A large steam launch is being laid down at the Thames Electric and Steam Launch Company's works at Eel Pie Island, Twickenham-on-Thames, to the order of Henry Astrop, Esq., of "Cintra," Fassett Road, Kingston. The power consists of compound surface condensing engines indicating about 85 horse-power. There will also be an electric light installation fitted on board. The dynamo will be coupled on direct with the engine on one bedplate, and the various rooms illuminated by incandescent lamps on the most improved principles. The dynamo will be shunt wound for charging accumulators for a small electrical pinnace. The whole of the work and construction of the vessel has been designed and moulded throughout by the company's general manager, Mr. W. S. Sargeant. She will be launched this year. There will shortly be a number of electric launches, fully equipped, ready for the coming season, including two electrical sailing gigs designed by Mr. Sargeant for sailing, rowing, or to be electrically propelled. The extensive buildings and improved slipway at Twickenham are now completed, and everything is well in hand for the coming season. In the engineering shops the company have in hand compound surface condensing marine engines of the latest designs, suitable for launches and seagoing yachts.

Lists, Calendars, &c.—With the permission of the National Telephone Company, the Solicitors' Law Stationery Company have published what is called the "Telephone and Telegraph Directory." This consists of a large card, 20 inches by 12 inches, on which are given the telephone numbers and telegraphic addresses of a number of firms and companies. In the centre of the card there is a neat calendar for 1893, while above this is a blank space so that users may fill in for their convenience the telephone numbers and telegraphic addresses of customers or others with whom they are constantly communicating. This would make the "directory" very useful if the card did not occupy so much space. We do not think the list of selected names will be of very great convenience to anyone.

The Commercial Cable Company have, according to their usual custom, prepared an almanack for the year 1893, on which are given the names of the directors and officials, also particulars of the many European and American establishments of the company.

An Explanation.—Mr. Rashleigh Phipps, of Oxford Street, W., asks us to give publication to the following explanation:—"I notice in the electrical and building papers a statement that the company known as Roger Dawson, Limited, has been formed to acquire the business of Rashleigh Phipps and Dawson. As this is calculated to be very detrimental to the public, and also to my interests, I beg to inform you that although under the terms of the dissolution between myself and Mr. Dawson, the property and assets of the old firm of Rashleigh Phipps and Dawson are assigned to Mr. Dawson, the deed provides that neither party shall use the name of the other in any shape or form whatever. I am now carrying on business at No. 102, Oxford Street, under the style of Rashleigh Phipps & Co., electrical engineers, and my business will be in no way affected by the company which has been formed."

Electric Light at the Royal Palace, Madrid.—We understand that Messrs. Planas Flaquer & Co., of Gerona and Barcelona, have received the order for the electric light installation at the Madrid Royal Palace. This will comprise some 6,000 incandescent lamps, and 32 arc lamps. The firm are concessionaries and sole makers for Spain of the dynamos, and of Messrs. Ganz & Co., of Buda Pesth. Amongst some private installations, Messrs. Flaquer and Co. have now in hand the contracts for the electric lighting of the towns of Granada, Ceuta, Folosa, Blanca, Segorbe, Ripoll and Taca; in the last-named town two electrical transmissions of 40 horse-power each, to two miles distance, are already at work, giving every satisfaction. The turbines for driving the dynamos for most of the central stations mentioned are also constructed by Messrs. Flaquer.

Awards.—Messrs. Ernest Scott & Mountain, Limited, electrical and general engineers, Close Works, Newcastle-on-Tyne, have been awarded a gold medal for the electric lighting of the Sheffield Trades Exhibition, and also a gold medal for the electric lighting of the Lincoln Trades Exhibition. In both cases the exhibition was lighted by one of Messrs. Scott & Mountain's latest type two-pole Tyne compound wound dynamo feeding 10-ampère Tyne arc lamps, the lamps being run in parallel.

An Electrical Fittings Manufacturer's Discharge.—At the London Bankruptcy Court on Tuesday last, an application was made to Mr. Registrar Linklater for an order of discharge on behalf of Victor Silberberg, 47, Oxford Street, W., electrical fittings manufacturer, trading as "The Electrical Fittings Manufacturing Company." Mr. Wildy, Official Receiver, reported that the failure occurred in October, 1891. The accounts filed by the debtor showed, ranking liabilities, £941 12s. 7d., against assets estimated to realise £185 4s., after deducting £40 in respect of the preferential claims. The bankrupt commenced business on his own account in 1885, with a capital of £20; but closed it in 1887, having made a loss of £300. During 1888 and 1889, the bankrupt was without occupation, and was supported by his wife. In January, 1890, he commenced business, without any capital whatever, except a further loan of £100 from his wife, as a manufacturer of electrical fittings, trading under the style of the "Electrical Fittings Manufacturing Company." The bankrupt continued that business until September, 1891, when he endeavoured to arrange with his creditors, and executed a deed of assignment for their benefit. Under that deed nothing appears to have been done by the trustee thereof, the bankruptcy proceedings following shortly afterwards. The bankrupt attributes his insolvency to proceedings taken against him by a creditor upon a bill of exchange, which he states was given on an understanding that it was to be renewed at maturity. The offences charged by the Official Receiver were (1) that the assets were not equal in value to 10s. in the £ upon the unsecured indebtedness; (2) imperfect book-keeping; (3) trading with a knowledge of insolvency; (4) contributing to the bankruptcy by rash and hazardous speculation; (5) contracting a debt provable in bankruptcy, without having, at the time of contracting it, any reasonable or probable ground of expectation of being able to pay it. Mr. Brown appeared for the bankrupt, who was absent by reason of illness. He did not dispute the Official Receiver's allegations, but simply addressed the Court in support of the application. The Registrar suspended the order of discharge for two years.

The Electric Lighting at Burlington House.—The Royal Chemical Society at Burlington House has just had the electric light laid on throughout the whole of the premises facing Piccadilly. At the recent first winter meeting, Sir Henry Roscoe, M.P., in the chair, the treasurer stated that, "the Society was under a special obligation to Prof. Ayrton for the great amount of thought and energy he had expended on the work." He also considered that the fittings, designed by Messrs. Faraday & Son, "did credit to the reputation of that firm for artistic work."

Edison & Swan.—The Edison & Swan United Electric Light Company, who, at the time of taking the extensive premises at Ponder's End, closed their works at South Benwell, Newcastle-on-Tyne, have found it necessary, in order to extend their facilities for the manufacture of high-class brass and other fittings, to reopen the works at Newcastle, which will be specially devoted to this department.

Ashes Washing Machine.—We recently described some ashes washing machinery which is being supplied by Mr. Leoline A. Edwards, of Laurence Pountney Hill, E.C. We understand that Mr. Edwards has been authorised by the West Hartlepool Steel and Iron Company, to supply them with large plant, having capacity to wash 150 tons per day.

Electric Lighting of Institution Offices.—The Council of the Institution of Mechanical Engineers have decided to light the offices of the Institution by electricity, and have retained Mr. Ed. C. de Segundo, A.M.Inst.C.E. & E.E., to advise them as to the system of wires, &c.

Kimberley Exhibition.—Messrs. Johnson & Phillips have been awarded a gold medal (highest award) for their dynamos at the Kimberley Exhibition, South Africa. The machine was exhibited by Messrs. Edlin and Stevenson, of Cape Town, their general agents in that part of the world.

Pyke, Harris & Co., Limited.—Among other work in hand, Messrs. Pyke, Harris & Co., Limited, are putting in the wiring and fittings for the New Zealand Government Offices, Victoria Street S.W., and William Lucas, Esq., 17, Ryder Street, St. James's.

Mavor and Coulson.—In connection with Messrs. Mavor & Coulson's electrical works in George Square, Glasgow, a public exhibition, illustrating the development which is taking place in electrical appliances, was held last Friday.

Electric Lighting of the Royal Academy Schools.—Messrs. Verity & Co., Regent Street, have been commissioned to fit up the schools of the Royal Academy, in the basement of Burlington House, with electric light.

Concert.—Last Friday evening the third staff smoking concert in connection with the City of London Electric Lighting Company, Limited, was given at Masons' Hall Tavern, Masons' Avenue.

Annual Dinner.—The annual dinner given by Messrs. Rosling and Matthews to their *employés* was held at the Market Tavern, Bradford, on Friday last, when about 50 persons sat down to dinner. A smoking concert was afterwards held.

Bankruptcy.—A list of the creditors of James K. D. Mackenzie, electrical engineer, of Broadway Chambers, Westminster, S.W., appears in *Stubbs's Gazette*. The total amount is £2,996 9s. 2d.

New Edition.—Mr. M. Powis Bale, M.I.M.E., A.M.I.C.E., of Appold Street, Finsbury, E.C., has just published the fourth edition of his "Handbook for Steam Users."

Catalogues, Price Lists, &c.—There is a great deal of competition noticeable of late in catalogue and list compilation. A very good catalogue has been got up by Messrs. Ernest Scott & Mountain, Limited, the subject being principally Electric Mining Machinery. As is stated in a prefatory note the book can only be regarded as illustrating a small section of the firm's manufactures in connection with mining work. Very interesting information is given on some of the first pages regarding the "advantages and relative cost of electric light and gas," and a comparative estimate is given of the respective total costs of the two illuminants. "Cost of installations" is the heading of another page on which are given the approximate costs of installations of 16-C.P. incandescent lamps; prices are given for installations consisting of from 15 lamps to 1,000 lamps. On another page a table is given showing hours of lighting throughout a year of 8,760 hours; this table is estimated to be of great value when calculating the comparative cost of electric light. Following this are set down instructions for fixing and working dynamo-electric machines. These instructions have been compiled by Mr. W. C. Mountain, and deal very minutely with all points connected with dynamo fixing. A description with a general specification of the Tyne dynamo occupies a number of pages. The illustrations seem to be very well cut, but they might have been better printed. Electric motors, electric pumping machinery with tables of the capacities of three-throw single-acting pumps, a description of the electric mining pump of the North Seaton type, Newton colliery pump, and a large quantity of other very useful information such as electrical haulage plant, electric hoists, cranes, capstans, punkah pullers, particulars regarding electric coal cutting, and various electrical apparatus and fittings is set down in very interesting style. On the whole the book is a first class one, and is well worth perusal, especially by those dealing in heavy electrical machinery. We have pleasure in recommending the catalogue to our readers' attention.

Messrs. Mackey, Mackey & Co., of Bouverie Street, Fleet Street, E.C., inform us that they have taken up the European agency for the sale of Messrs. Waite & Bartlett's (of New York) electro-medical and electro-surgical appliances. Messrs. Waite's high class and strictly scientific manufactures, which are used by large numbers of physicians and in many hospitals, are well known in this country. We have received a copy of their catalogue of these appliances, which do it justice is entitled to more space than we are able to spare for a notice of it. The book contains a large number of interesting illustrations, in fact every apparatus mentioned has a cut to illustrate it. Electro-medical men will do well to procure a copy of this catalogue as it will be of much use to them. The prices of the various articles are set down in American money, but Messrs Mackey, Mackey and Co. intend to publish shortly a new catalogue with the prices in English money, at the same time adding particulars of certain goods of their own manufacture which do not appear in Messrs. Waite's book. It is Messrs. Mackey's intention to keep a stock of all the principal goods enumerated in the book, at the address given above. We can conscientiously recommend this publication to the attention of all connected with this special branch of the trade, as it is undoubtedly one of the best of its kind that has yet come before us.

An illustrated and priced catalogue of small dynamos, motors, and electrical appliances has lately been brought out by Messrs. Cuttriss, Wallis & Co, Limited, Camp Road, Leeds. Amongst the descriptions of various apparatus are particulars of dynamos for students, eclipse dynamos, improved ring dynamos, "Elmwood" dynamos and motors, electromotors, dental motors, motor and fan batteries, accumulators and gas engines.

Browett, Lindley & Company, Limited.—This firm has been well supplied with orders during the greater portion of last year both for electric lighting engines and their "Acme" governors, as well as general engineering work, though for several weeks in the early part of the year business was much interrupted through the removal from Salford to their new works, which they have built at Patricroft, near Manchester, production being naturally checked during the transit and re-erection of an extensive engineering plant. However, now that the new works are in full swing, the advantages of modern works, with good lifting machinery and many new machine tools, are making themselves felt in every department. Amongst other work which the firm have constructed during the year may be mentioned about 50 engines for ship electric lighting, a 150 H.P. vertical compound condensing engine for electric lighting in Woolwich Arsenal, an engine of 75 H.P. for the British Insulated Wire Company, Limited, Prescot, a compound engine for an establishment at Llandudno for electric lighting, a horizontal engine for Lloyd's House, Manchester, also an engine for the lighting installation of the new Salford Sanitorium; engines for Messrs. Haworth's Mills, Salford; Messrs. Brown's building yard, and a margarine factory, together with several compound engines for Spain and Russia. The firm also built a large horizontal compound tandem condensing engine, together with a large quantity of pulleys, shafting, &c., for a cotton mill in Spanish Columbia, and a 30 H.P. horizontal engine for the Manchester Corporation. The "Acme" governor still maintains its reputation, which is proved by the greatly increased output in this department during the year. At the recent Electrical Exhibition, held at the Crystal Palace, the firm obtained a silver medal for the excellence of their exhibits. During the year Mr. F. C. Gibbons, late of Wantage, has joined the firm as an acting director, sharing the commercial work with Mr. Browett, whilst the works are under the special care of Mr. Lindley. The firm have been placed on the Admiralty list for the supply of electric light engines. Having a good share of work to commence this year with, including the order for the whole of the steam engines, piping, and condenser required for the Derby Central Electric Lighting Station (to the order of Messrs. Siemens Bros. & Co., Limited, Woolwich), a large engine for a Kent tannery, engine for extension of Prescot lighting, &c., they should soon begin to reap much advantage from their move to their present large and well-equipped works.

Electric Light in the West End.—Among the new contracts recently completed, or at present in hand, we may mention that Messrs. Bergtheil and Young, of Walbrook, E.C., are fitting up the Duchy of Lancaster offices, Lancaster Place, Waterloo Place.—Messrs. Watson, Giesenheimer & Co., of Glasshouse Street, W.C., are fitting up the premises of Messrs. F. Lack & Sons, hosiers, in the Strand.—Messrs. Stevens and Sons, Limited, have recently had some electric lighting work carried out in their premises in Chancery Lane.—A contract has recently been completed in the offices of Messrs. Clinton & Co., solicitors, Newstone Buildings, Chancery Lane.—Messrs. C. Wintton & Co., of Goodge Street, Tottenham Court Road, is engaged upon work in the premises of Messrs. Coupier & Druart, 76, High Holborn.—Electric light fitting work has also recently been completed in the premises of Henry Leath & Co., 302, High Holborn; Leahy's cigar stores, 303, High Holborn; Messrs. Hoare & Sons, 252, High Holborn; Messrs. S. E. & L. Phillips, 250, High Holborn; Messrs. Myer Bros., 203, High Holborn; and Mr. D. L. Isaacs, 46, New Oxford Street.—Messrs. C. Wintton & Co., of 35, Goodge Street, E.C., are fitting up the premises of the Wine Growers' Association, New Oxford Street.

CITY NOTES.

The St. James' and Pall Mall Electric Light Company, Limited.

THE following is a copy of the Directors' report and statement of accounts for the year ending 31st December, 1892:—"The Directors beg leave to submit their annual report for 1892, the accounts accompanying the same being duly certified by the company's auditors. Owing to difficulties with regard to ancient lights and other matters, it was found impossible to complete the Northern central station within the time contemplated. It is now, however, practically finished and complete with sufficient machinery for the supply of 20,000 8-C.P. lamps, which, when necessary, can be augmented by further plant, raising the capacity of the station to 65,000 8-C.P. lamps. The two stations are already connected by the great trunk main, and within a very short time they will not only be able to run concurrently, but will be able to relieve each other should necessity arise. The directors are pleased to be able to report that the plant at the southern central station is in perfect order, and fully maintains the efficiency and economy noted last year. It has, unaided, produced the income shown in the accounts. The directors have devoted great attention to the curtailment of all unnecessary expenditure in which they have been ably seconded by the officers and staff of the company. Their policy has, however, been that of maintaining the buildings, plant and mains of the company in the highest state of efficiency. They are not only advised, but their experience has satisfied them, that to earn continuous dividends in a business of this character, liable as it is to many risks, and dependent on the correct handling of the multitudinous details, it is essential that the whole of the company's works and mains should be thoroughly maintained in every respect. The whole of the compulsory mains are now laid, and this, together with the amounts required for the completion of the new station, has caused a large capital expenditure during the year, which has as yet produced no corresponding income. The directors are happy to state that the works have been completed at a cost well within the estimates, and they do not anticipate that any further capital will be required unless a demand should arise for current in excess of the company's present capacity. The question of the "redemption fund," inaugurated last year, is one which has been prominently brought to the attention of the directors by certain holders of founders' shares, who consider that the amount is improperly taken from "revenue account," and should be divisible as profit amongst the shareholders. This question was before the meeting of the members of the company last year, when the creation of the fund was approved, *nem. con.* The directors therefore recommend that this policy be maintained, believing that it is one which will meet with the continued approval of the shareholders. In their judgment, the establishment of this fund is prudent, and they are advised that it is in strict accordance with law. The directors regret to announce that the action brought against the company by Dr. John Hopkinson, for the alleged infringement of his three-wire patent, has been decided against the company. Pending the consideration of whether the company should appeal, they are glad to be able to state that they have completed arrangements whereby they will be in a position to continue the supply of current without interruption, and without further use of the patentee's system. The company will not have to bear the whole of the costs of the action. The net earnings of the company during the past year have amounted to £14,598 16s. Of this sum, £5,997 10s. was distributed in July last in payment of an interim dividend at the rate of 5 per cent. per annum for the half-year ending June 30th, 1892, on the ordinary shares, and at the rate of 7 per cent. per annum on the preference shares. The balance, £8,601 9s., together with the undivided profits of £22 12s. 2d. from last year's account, leaves £8,624 1s. 2d. now to be dealt with. The directors propose to divide this amount as follows:—(*a*) By payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year, £3,500; (*b*) By payment of a dividend at the rate of 9½ per cent. per annum for the second half-year on the ordinary shares, making, with the interim dividend paid in July last, a total distribution of 7¼ per cent.

for the year, £4,745 5s.; (*c*) By paying a dividend of £3 3s. per share on the founders' shares, £315; (*d*) Amount to be carried forward to ordinary shareholders' undivided profit account, £59 7s.; (*e*) Amount to be carried forward to founders' undivided profit account, £4 9s. 2d. The directors have carried £1,000 to increase the redemption fund, which, with the addition of interest received during 1892, now stands at £2,029 6s. 4d., and which is accumulating by annual additions towards representing loss of capital at the expiration of the term covered by the provisional order. The directors are advised that the amounts provided in the accounts for depreciation are sufficient and ample for all purposes. The directors regret that Mr. Charles Showell, one of their number, found it necessary to resign his seat on the board, owing to his numerous engagements. They elected Mr. Gerald W. Balfour, M.P., brother of the chairman, to fill the vacancy thus created, being of opinion that his services would be of great value to the company. Sir John H. Morris, K.C.S.I., and Mr. Gerald W. Balfour, M.P., retire under Clause 79 of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and, being eligible, offer themselves for re-election.

ABSTRACT OF ACCOUNTS TO DECEMBER 31ST, 1892.

CAPITAL ACCOUNT.

Dr.	£	s.	d.
To Expenditure per last account	139,458	1	11
„ Further expenditure to December 31st, 1892	55,561	6	3
„ Balance of capital expenditure	14,670	6	3
	209,689	14	5
„ Less depreciation fund account	9,689	14	5
	£200,000	0	0

Cr.	£	s.	d.
By Ordinary shares	99,900	0	0
„ Preference shares	100,000	0	0
„ Founders' „	100	0	0
	£200,000	0	0

REVENUE ACCOUNT.

Dr.	£	s.	d.
To Generation of electricity „ Distribution of electricity	11,268	1	5
„ Proportion of rents, rates and taxes	818	1	9
„ Proportion of management expenses	3,666	6	3
„ Proportion of law and parliamentary charges	284	10	6
„ Special charges, £193 10s 10d.; depreciation, £3,869 15s.; redemption fund, £1,000	5,063	5	10
„ Balance	13,458	19	5
	£34,559	5	2

Cr.	£	s.	d.
By Sale of current per meter „ „ „ under contract	33,397	4	1
„ Rental of meters, converters, &c.	546	5	0
„ Transfer fees	90	15	0
„ Rents receivable	401	18	10
„ Other items	123	2	3
	£34,559	5	2

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
To Balance, being net profits applicable to dividends on shares	14,621	11	2
	£14,621	11	2

Cr.	£	s.	d.
By Balance from account, less dividends paid	22	12	2
„ „ „ revenue account	13,458	19	5
„ Interest on money at deposit, &c.	1,104	2	1
„ Profit on sale of consols	35	17	6
	£14,621	11	2

RESERVE FUND.

Dr.	£	s.	d.
To Balance	15,000	0	0
	£15,000	0	0

Cr.	£	s.	d.
By Premium of £1 10s. per share on issue of 10,000 preference shares in December, 1891	15,000	0	0
	£15,000	0	0

GENERAL BALANCE-SHEET.

Dr.	£	s.	d.
To Capital account	200,000	0	0
„ Sundry tradesmen and others, on construction of plant, machinery, fuel, &c.	2,467	8	3
„ Sundry creditors on open accounts	1,383	16	1
„ Reserve fund account	15,000	0	0
„ Net revenue account, balance at credit thereof £14,621 11s. 2d.; less interim dividends paid on ordinary and preference shares	8,624	1	2
„ Redemption fund and unclaimed dividends	2,032	8	10
	£229,507	14	4

Cr.	£	s.	d.
By Capital account	185,329	13	9
„ Cash at bankers and in hand	13,339	12	3
„ Sundry debtors for current, and other debtors	10,964	13	11
„ Stores on hand	3,190	8	1
„ Law charges in suspense (three-wire action)	654	0	0
„ Reserve fund investment, 2½ per cent.	15,000	0	0
„ Redemption fund investment	1,029	6	4
	£229,507	14	4

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors of the Anglo-American Telegraph Company, Limited, held last Friday, it was resolved to recommend to the proprietors at the next half-yearly general meeting of the company, to be held on January 27th next, the declaration of the following dividends:—1. A balance dividend of 17s. 6d. per cent. upon the ordinary consolidated stock for the year ending December 31st, 1892. 2. A balance dividend of £1 15s. per cent. upon the preferred stock for the year ending December 31st, 1892, both payable on January 28th next, less income tax, to the stockholders registered on the books of the company on the 10th inst. After paying the foregoing dividends, there will be a balance of about £737 to be carried forward to the next account. The above dividends, together with those already paid, will amount to £2 15s. per cent. on the ordinary consolidated stock, and £5 10s. per cent. on the preferred stock, for the year 1892. The register of transfers will be closed from January 13th to January 27th, both days inclusive.

Companies Struck Off the Register.—The *London Gazette* states that the following companies have been struck off the register, and are therefore dissolved:—Devon and Cornwall Electricity Supply Company, Limited; Douglas Patent Clock and Electric Meter Company, Limited; Jensen Electric Manufacturing Company, Limited; Kingston-upon-Hull Electric Lighting and Supply Company, Limited; Leicester Electric Light and Power Company, Limited; Liverpool Central Hydro-Electric and Massage Company, Limited; Patent Self-Binding Telegraph Insulator Company, Limited; "Rees" Miners' Patent Safety Electric Lamp Company, Limited; Schoth's Electro-Medical Apparatus Company, Limited; Series and General Electric Traction Company, Limited; Sunderland and District Electricity Supply Company, Limited.

Electro-Mechanical Company of Paris.—The capital of the Electro-Mechanical Company (Paris), which was originally 300,000 fr., has been increased to a million, and divided into 2,000 shares of 500 fr. each, out of which 300, entirely free, have been granted to the Continental Edison Company, and 300 more to the Weyher and Richmond Company and the Jean-Jacques, Heilmann and Company, in return for their support.

Paris Submarine Telegraph Company.—At the special meeting of the shareholders of this company, which took place on December 14th, the following directors were appointed: Messrs. Leanté, Lefaivre, Videl, Rear-Admiral Caubet and Rouget, formerly treasurer. The meeting then accepted the resignation of Messrs. J. Lair, E. Clerc, J. Kulp, E. May, A. Sienkiewiez, A. Viugner, R. Wallut and P. Wallerstein.

The Direct United States Cable Company, Limited.—The board of directors last Friday, resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income tax, being at the rate of 3½ per cent. per annum, for the quarter ending 31st December, 1892; such dividend to be payable on and after the 28th inst., placing £4,000 to reserve fund account and carrying forward £3,129 0s. 7d.

Paris Electrical Meter Company.—The shareholders of the Paris Electrical Meter Company, which started with a capital of 100,000 fr., met on December 28th for the purpose of approving the accounts, and considering certain modifications to be made in the statutes.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 15th, 1893, amounted to £1,007; week ending January 17th, 1892, £836; increase £171; total receipts for half-year, 1893, £2,005 corresponding period, 1892, £1,694; increase £311.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 13th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,664.

The West India and Panama Telegraph Company. The receipts for the two weeks ended January 15th, show an increase of £201 as compared with the corresponding period.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, January 12th.	Closing Quotation January 19th.	Business done during week ended January 19th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 – 103	100 –103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	51½ – 52⅜	53½ – 54½	53⅞	53¼
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	92½ – 93⅛	96½ – 97½	96¼	94⅜
2,876,140*l*	Do. do. Deferred	Stock	11 – 11½	12¼ – 12⅜	12 11/16	12
130,000	Brazilian Submarine Telegraph, Limited	10	11 – 11½	11 – 11½	11⅜	11⅛
34,630*l*	Do. do. 5 p. c. Bonds	100	101 –104	101 –104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 –118	104 –108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 – 3¼	3⅛ – 3⅜	3⅛	3 3/16
75,000	Do. do. Non cum. 6 p. c. Preference. Nos. 1 to 63,416	2	2¼ – 2⅜	2¼ – 2⅜	2 2/16	2⅜
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	100 –102	101 –103	102½	101
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 – 4	3 – 4	...	...
600,000*l*	City and South London Railway	Stock	35 – 38	35 – 38	36⅓	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10⅜ – 11¼	11⅛ – 12	12	10⅞
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	5⅛ – 5⅜	7⅜ – 8⅛	8⅛	5¼
$7,716,000	Commercial Cable, Capital Stock	$100	175 – 180	175 –180	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16 – 5/16	3/16 – 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 – 5⅛	5 – 5⅛	5⅛	...
16,000	Cuba Telegraph, Limited	10	11½ – 12½	12 – 13	...	...
6,000	Do. do. 10 p. c. Preference	10	17½ – 18½	17½ – 18½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2 – 3	2 – 3	...	...
6,000	Do. do. 10 p. c. Preference	5	9 – 10	9 – 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11¼ – 11⅜	11½ – 11⅝	11⅝	11⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜ – 15	14⅝ – 14½xd	14¼	14⅛
70,000	Do. 6 p. c. Preference	10	16 – 16½	16 – 17 xd	16½	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 –110	107 –110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	110 –113	110 –113	112½	112
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜ – 15	14⅜ – 15 xd	15	14 13/16
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 –105	102 –105	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 –105	102 –105	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	111 –114	111 –114	...	...
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 –104	101 –104	...	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 –104	101 –104	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 –106	103 –106	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	2¼ – 2⅜	2¼ – 2⅜	2⅜	2¼
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	.. ..	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/16 – 1/8	1/16 – 1/8	1/8	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/8 – 1/4	3/8 – 1/4	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	3/8 – 1/4	3/8 – 1/4	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 – 3	2 – 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ – 9⅞	9⅜ – 10	9⅞	9⅝
180,042	Do. do. 6 p. c. Preference	10	15 – 15¼	15 – 15¼xd	15 1/16	15
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜ – 19¼	18⅜ – 19¼	18⅝	...
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 –107	105 –108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ – 5½	4½ – 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	8 – 9	8 – 9	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ – 22½	21½ – 22⅜	22⅛	21⅞
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 –104	102 –104	...	...
17,000	Indo-European Telegraph, Limited	25	44 – 46	44 – 46	44⅜	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ – 3½	2½ – 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 – 7	6 – 7	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	3⅝ – 3¾	3¾ – 4	4⅛	3⅞
10,000	Do. do. fully paid	5	5¼ – 5½	5½ – 5¾	5¾	5⅝
38,348	London Platino-Brasilian Telegraph, Limited	10	4 – 6	4 – 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 –111	108 –111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6¾ – 7¼	6¾ – 7¼	7	6¾
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 –105	102 –105	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4¾ – 5	4¾ – 5	5	4 15/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 – 15	14 – 15	15	14 15/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13¾ – 14½	13¾ – 14½	14 3/16	14 1/16
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4¼ – 4½	4¼ – 4⅜	4 7/16	4⅜
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	111 –113	112 –115	113½	112¾
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	4¾ – 5	... ...	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 – 6	5 – 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 – 5/16	3/16 – 5/16	...	...
11,802	Reuter's Limited	8	7½ – 8½	7½ – 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¾ – 8¼	7¾ – 8	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8¼ – 8¾	8¼ – 8¾	8 7/16	...
3,361	Submarine Cables Trust	Cert.	117 –122	117 –122	120	...
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	3 – 3½	3 – 3½	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 – 47	45 – 47	46¾	45½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 –104	101 –104	...	...
58,000	United River Plate Telephone, Limited	5	2½ – 3	2½ – 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 – 100	90 –100 xd	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ – 7½	6½ – 7½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	101 –104	101 –104	101½	...
30,000	West Coast of America Telegraph, Limited	10	2½ – 3½	2½ – 3½	...	...
150,000*l*	Do. do. do. 5 p. c. Debs., repayable 1902 ...	100	101 –105	101 –105	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7½ – 8	7⅞ – 8½	8	7⅞
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5⅞ – 6¼	5⅞ – 6¼	5⅞	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1¾ – 2¼	1⅝ – 2⅛	2 1/16	1⅞
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 –109	106 –109	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 –109	106 –109	109	106½
88,321	West India and Panama Telegraph, Limited	10	1¼ – 1½	1⅜ – 1⅝	1 7/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10¼ – 10⅝	10¼ – 10⅝	10⅜	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ – 9½	8½ – 9½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	104 –107	105 –108	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 –125	120 –125	...	...
177,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 –103	100 –103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ – 6	5½ – 6	5 15/16	5⅝

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. Bank rate of discount, 3 per cent. (October 20th, 1892.)

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100–103.—Electric and General Investment, shares of £5 (£1 paid), 1⅞—2⅛xd.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5¼.—Elmore Foreign and Colonial Copper, Founders shares, 6¼—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5—5½.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6 .—Liverpool Electric Supply Shares of £5 (fully paid), 5¾—5¾.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Debentures, 101—103.—Woodhouse and Rawson £5 Preference (fully paid), ¾—1¼.

ROTATING ELECTRIC FIELD, AND ROTATIONS DUE TO ELECTROSTATIC HYSTERESIS.*

By DR. RICCARDO ARNÒ.

IN his known researches on the *electro-dynamic rotations produced by means of alternating currents*, Prof. Galileo Ferraris demonstrated that by means of two simple alternating currents, working in immovable coils, a rotating magnetic field could be generated, and, by means of the phenomena of induction, which present themselves in Arago's ancient and classical experiment, the rotation of a copper cylinder, placed in such a field, could be obtained. Moreover, in one of his fundamental experiments, Mr. Ferraris demonstrated that in a rotating magnetic field an iron cylinder turns, even when it is cut in such a way that no Foucault's currents may be produced; in this case he remarked that the rotation is due to magnetic hysteresis, viz., to the lag with which the magnetisation of iron follows the rotation of the magnetic field.

My experiments, following this line of thought, show that when magnetic forces are substituted by electric forces, and magnetic bodies are substituted by dielectric ones, phenomena like those experienced in the case of the cut iron cylinder present themselves.

Even before Mr. Proteus Steinmetz's † experiments, from the simple fact that in the dielectric of a condenser, inserted in the circuit of an alternating electromotive force, a consumption of energy takes place, which shows itself by means of a production of heat in the dielectric itself, it already resulted that in the dielectric medium, under the influence of an alternating electrostatic field, a phenomenon of *electrostatic hysteresis* happens, like that of magnetic hysteresis, which presents itself in the magnetic bodies placed in an alternating magnetic field. It was then easy to be foreseen that a similar phenomenon, as the rotation of a cut cylinder of a magnetic material, would have been obtained upon a cylinder of an insulating material placed in a *rotating electric field*. In this case, also, the rotation of the cylinder should be caused by the lag with which the polarisation of the dielectric body follows the rotation of the electric field to which it is due.

Therefore, it was a natural thing that, in order to verify experimentally those provisions, I had recourse to considerations and dispositions similar to those used by Prof. Ferraris in his experiments on the electro-dynamic rotations. If, in fact, in a point, O (fig. 1),

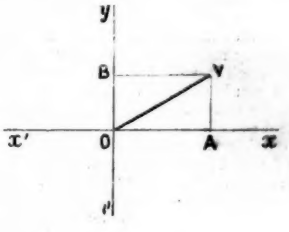


FIG. 1.

instead of two magnetic fields as Ferraris did, two electric fields are put one upon the other, in the directions, O x and O y, they cause, similarly, a resulting electric field, whose intensity, O V, is to be obtained by resolving the intensities, O A, O B, of the two electric fields as two forces, provided, however, that the space, in which the two fields are situated, be occupied by a substance whose dielectric constant may have in every point the same value. If, moreover, the two electric fields vary according to the sinusoidal law, and have the same period and a difference of phase, then the point V describes an ellipses, with a centre O, which is reduced to a circle if the amplitudes of the two resolved fields are equal, and, the directions of the two fields being normal, if the angular value of the difference of phase is equal to 90°. In this particular case, the resulting electric field has a constant intensity and a direction spinning with uniform velocity. And as the two magnetic fields destined to generate a rotating magnetic field can be obtained by means of two alternating currents going through two immovable and crossed coils, in a similar way the two electric fields necessary to produce a rotating electric field can be obtained by means of two alternating differences of potentials between two couples of metallic fixed and crossed segments.

In order to derive the two differences of potentials necessary for my experiment, without being obliged to have recourse to a dynamo or an electrostatic polyphase machine, I had recourse to a disposition like one of those used by Prof. Ferraris, in his classical experiments, to derive from a single circuit the two alternating currents which he was in want of for the production of his rotating magnetic field. I intend speaking of the disposition, which consists in using the currents of two derived circuits in which equal apparent resistances, essentially constituted, the one by a great ohmic resistance and the other by a great inductance, are inserted. The same considerations, which stand for two parallel circuits, can, in fact, be repeated for two series circuits, provided the differences of potentials at the ends of these circuits be considered instead of the currents flowing along the former; while in the first case the main current divides itself in two currents presenting the difference of phase necessary for the production of the rotating magnetic field, in the second case, the given difference of potentials subdivides itself in two differences of potentials, which are also displaced in their phase, as it is required for the generation of the rotating electric field. It is needful, however, to remark at once that in this as well as in the other case, the required difference of phase can be obtained by means of condensers. Nay, the employment of condensers, which in the experiments on the rotating magnetic fields is not deprived of practical difficulties, turns out to be very convenient here, where, being the case of very high potentials and very feeble currents, but little electrostatic capacities are required.

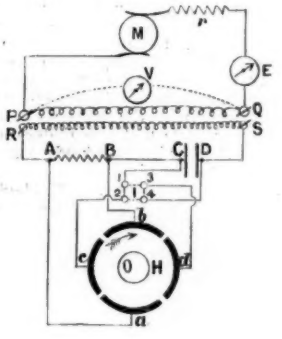


FIG. 2.

In fig. 2 is shown the arrangement of circuits in my experiments. In M a Siemens low tension alternator is represented; in r an industrial rheostat; in E a Siemens electro-dynamometer; in V a Cardew's voltmeter, and in P Q, R S, respectively, the primary and secondary wires of a large Ruhmkorff's coil deprived of the commutator, and used as a simple transformer destined to produce a high difference of potentials between the two points R and S, as it is necessary for the experiment. In the secondary circuit of such apparatus are inserted a great ohmic resistance, A B, without self-induction, and a condenser, C D, whose electrostatic capacity may be very small. The four points, A, B, C, D, are respectively put in communication with four somewhat curved vertical copper segments, a, b, c, d, arranged as shown in the drawing. A mercury commutator, I, serves to invert the joinings of the two segments, c and d, with the points, C and D. A Thomson's electrostatic voltmeter, not shown in the drawing, serves as a measure of the differences of potentials between A, B, and C, D. In fig. 3 is perspectively drawn the arrangement of the four segments, a, b, c, d, enclosing the space in which the rotating electric field is to be produced. In order to make the figure clearer, the said segments are shown much narrower than they really are. The axis of the apparatus is shown in O, and the terminals, by means of which the four segments are joined with the points, A, B, C, D (fig. 2), are shown in m.

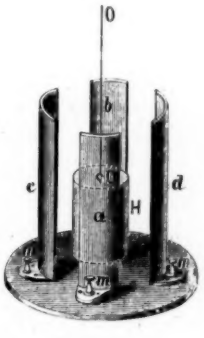


FIG. 3.

Once things are thus arranged, it is easy to foresee what was verified by experience. In fact, let us consider the secondary circuit of the transformer, comprising the secondary wire, R S, of the same, the resistance, A B, and the condenser, C D, and let us call i the intensity of the current in such a circuit, v_1 and v_2, respectively, the differences of potentials between the ends of the resistance, A B, and

* *Comptes Rendus.*

† *Elektrotechnische Zeitschrift*, April 29th, 1892. Dielektrische Hysteresis, der Energieverlust in dielektrischen Medien unter dem Einfluss eines wechselnden elektrostatischen Feldes.

between the armatures of the condenser, C D. We know that, while between the current, i, and the difference of potentials, v_1, there is no difference of phase, the current, i, is ahead of a quarter of period of the difference of potentials, v_2. Then v_2 lags a quarter of period behind v_1. A single glance at fig. 2 is then sufficient to show that the electric field, yielded by the two differences of potentials, v_1 and v_2, in the space enclosed between the four segments, a, b, c, d, must turn in the direction of the hands of a clock, when the commutator, I, is in the position, 1-2, 3-4, shown in the fig., and in the opposite direction, when the joinings of the segments, c and d, with the points, C and D, are inverted by means of the commutator, I, what is equivalent to varying by half a period the phase of the difference of potentials between c and d. If, however, the resistance, A B, and the electrostatic capacity of the condenser, C D, are properly determined, so that, as may always be obtained by trials, the two differences of potentials, v_1 and v_2, and consequently the mean intensities of the two composing electric fields may result equal, the resulting field has a constant intensity, and turns with uniform speed.

In a first experiment I suspended in the rotating electric field, by means of a silk thread, a little hollow mica cylinder, H. As long as only one of the two couples of segments, a, b, and c, d, is in communication with the points, A, B, or C, D, the little cylinder remains immovable; but when both couples of segments are respectively in communication with the points, A, B, and C, D, the little cylinder immediately begins to turn around its own axis, and in the direction of the arrow shown in the figure, if the commutator, I, is in the position 1-2, 3-4, exactly as was foreseen. If, while the cylinder is spinning in such a direction the position of the commutator, I, is inverted, the rotation rapidly ceases, and begins in the opposite direction. The experiment was repeated with the same result by substituting for the little mica cylinder little hollow cylinders of paraffined paper, glass, ebonite, wax, and other insulating substances.

In another experiment I combined a *small electrostatic motor*, working by means of alternating differences of potentials. Fig. 4 (scale

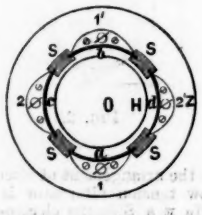


FIG. 4.

1 : 6) is drawn a normal to the vertical axis of rotation, O. The fixed part of the apparatus is constituted by four vertical copper segments, a, b, c, d, like those used in the foregoing experiments; they are separated, the one from the other, by means of four ebonite strips, S, and fixed by screws to an ebonite disc, Z. The copper segments and the ebonite strips form together a cylinder, whose height is 20 cm., and inside diameter 10 cm. The movable part consists of an hollow closed ebonite cylinder, H, which is movable around its axis, O, and sustained by two steel points, turning in glass holes. Such a cylinder has a weight of 40,330 gr., a length of 18 cm., and an outside diameter of 8 cm.

To put the above-described little motor in action, I arranged the experiment exactly as indicated in fig. 2, joining the terminals, 1 and 1', of the segments, a and b, with the points, A and B, and the terminals, 2 and 2', of the segments, c and d, with the points C and D. The condenser, C, D, was constituted by a simple wineglass, 1 mm. thick, containing some mercury, and covered on the outside by a tinfoil of a surface of about 1 dm². Its electrostatic capacity was therefore very small, about $3 \cdot 10^{-4}$ microfarads. In order to have the resistance, A B, free from self-induction, I firstly had recourse to a little boxwood bar, sufficiently dried, in which, at different distances, little wells containing mercury had been made; afterwards, with much better results, I had recourse to a column of distilled water, 3·5 mm. in diameter, whose length might be varied in order to obtain such conditions of circuit as to meet the requirements of a better working of the apparatus. The effectual intensity of the alternating current in the primary circuit was 7 amperes, the frequency 40, and the effective difference of potentials at the two ends, P and Q, of the primary coil of the transformer, 27 volts. The experiment demonstrated that the best working of the little motor was obtained when the effective difference of potentials between the points, A and B, was equal to that between the points, C and D. Such difference of potentials, measured by means of a Thomson's electrostatic voltmeter, was equal to 3,800 volts, and the column of water inserted between A and B, which had in that case a length of 54 cm., had, at a temperature of 22½°, a resistance of 13·5 megohms. In these conditions the ebonite cylinder put itself spontaneously in movement and acquired, after a few minutes a speed of about 250 turns at 1'; and if, by means of the commutator, I, the joinings of the segments, c and d, with the points, C and D, were inverted, the direction of the rotation was inverted likewise.

In other experiments I arranged also a condenser, made of one or more Leyden jars in parallel with the secondary coil of the transformer; by so doing I could remarkably increase the differences of potentials between the ends of the resistance, A B, and between the armatures of the condenser, C D, so that the intensities of the two electric fields were increased and greater effects could be obtained.

At last, to have an idea of the order of magnitude of the moment of the couples of rotation which can be obtained, I suspended to a bifilar suspension (in the rotating field of the foregoing experiment), an ebonite cylinder, 139 mm. long and 61 mm. in outside diameter. A little plane looking glass attached to the cylinder served to measure the angle of rotation. An approximate measure of said angle could be had also by means of an index and a graduated circle. This circle, fixed on the upper ends of the segments, a, b, c, d, so as completely to shut the cylinder formed by them, had in the same time the effect of eliminating the disturbances produced by air currents. The weight sustained by the bifilar suspension was of 23,053 grammes = 22,615 dynes; the distance between the two threads, 4,6 cm.; their length, 155 cm.; the deflection, 3°17'; and, therefore,

the moment of the couple of rotation, $176 \frac{\text{centimetre}^2 \cdot \text{gramme}}{\text{second}^2}$.

The above described experiments can be utilised to demonstrate in an experimental way the phenomenon of the electrostatic hysteresis in the dielectric bodies, and to put in evidence the existence of the differences of phase, which can be had by two alternating differences of potentials of equal period. They offer, moreover, a means for quantitative researches on the electrostatic hysteresis, and on its way of acting for various differences of potentials, and for the several dielectric bodies.

According to this order of ideas I am pursuing my researches.

In the meanwhile, I must testify my liviest thankfulness to Prof. Galileo Ferraris, whose advice very greatly assisted me in my work.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

AN ordinary general meeting of this Institution was held on Thursday, January 12th, Professor W. E. AYRTON, F.R.S., Past-President, in the chair.

The minutes of the last ordinary general meeting having been read and approved, and other general business transacted, the adjourned discussion on Dr. Fleming's paper on "EXPERIMENTAL RESEARCHES ON ALTERNATE CURRENT TRANSFORMERS," was resumed.

Prof. FITZGERALD: It seemed to me that those engaged in the discussion had not noticed or had not paid attention to a warning which Sir William Thomson had called attention to as to the eddy currents which would be produced in the thick wire of a transformer if it was sufficiently thick. One of the points he called attention to was that in the case of a continuous current transformer, a closed circuit transformer, there was no magnetic force outside the coils, no magnetic induction outside the coils, and consequently a piece of copper outside the coils will not have electric currents induced in them, while a piece of copper inside the coils will have eddy currents induced in it, because unless there is actually magnetic force at the place it will not indnce eddy currents, although it will induce a current continuously round in the circuit. If you have got an iron ring magnetised by means of coils of wire, and the coils of wire may be represented as being in this region outside, and of course partly distributed around the inside, a piece of metal outside there will have no eddy currents produced in it. A piece of metal inside the coils, or within the outside of the circuit, will have eddy currents produced in it. That is, although a wire completely surrounding a ring, would, of course, have a current induced in it, a wire lying outside, no matter how thick it was, would not have eddy current induced, but only the useful current you want produced in it. A point that Professor Ayrton wrote to me recently about was upon this very question as to how it happens that although there is induction tending to produce a current round the ring, there is no induction tending to produce eddy currents in the ring, which is outside the closed circuit; this is, of course, upon the simple hypothesis that there is no leakage of magnetic lines out of your closed circuit into the regions outside. It is very important, of course, to distinguish between lines of force which are due to imperfections in your magnetic circuits and the lines which would be the case if your magnetic circuit were perfect. The first case I want to call attention to is the case of your magnetic circuit being perfect. In that case no quantity of thick wires outside your magnetic feed are of importance. The thickness of them is of no importance; there will not be any eddying produced in them. The thing that is really of interest is the question as to whether, in order to avoid the eddy effect, you should wind the thick wire on the outside of the transformer or on the inside of the transformer, whether the thick wire should be wound outside the thin coils or inside the thin coils. Well, in a closed circuit transformer such as the simple case which I am taking, in which there is no leakage of the lines, it is, on the whole, I think, better that the thick coils should be on the outside; but in order to avoid this eddying I think there is no doubt at all that the driving circuit should be on the inside. Whichever is the driving circuit, the thick or the thin one, that I think ought undoubtedly to be on the inside. The next question is, where should the thick wire be? That of course depends upon whether you are transforming up or transforming down. You first of all arrange the inside driving rather than the outside driven. Still it is well to consider what would be the effect of having this the thick coil. Well, I really think it does not very much matter; but if you have a thick coil and insist upon having it outside, you had better transform in this direction than in that direction, because the average magnetic force is less in this than in that. This is only as regards the magnetic force which is normally present in a continuous circuit transformer within the coils not due to leakage. Then came the question, supposing you

had to take into consideration the leakage effects, which would be best, to put the thick copper wire on the inside or the outside? On the face of it the leakage of lines of induction out of the iron is denser in the neighbourhood of the iron than it is further away. Lines of induction spread out from the iron in general in the air outside, and consequently the density of the lines of force will be greater close to the iron than outside, so that for a given mass of iron or a given mass of copper, or rather for a thick mass, it would be better to have it as far from the iron as you can. Therefore, so far as leakage of the lines of induction is concerned it would undoubtedly be best to have a thick wire on the outside; because, so far as leakage and lines of induction are concerned they would be denser near the iron than outside. Then comes the question, if you do want the thick coil on the outside there will be more copper in which there will be this eddying effect, and do you thereby increase the heat production iu that copper by having more copper? Well, the question is not, I think, capable of being solved with absolute certainty all in a moment, but I think there are certain considerations that make it almost certain that with more copper it is undoubtedly desirable to have that copper as far from your iron as possible.

Prof. PERRY: I have proved in a Royal Society paper that in all calculations on transformers except one, namely, where you want to calculate the current supplied to an unloaded transformer, it makes no difference whether you take into account hysteresis, eddy currents, and so on. I mean in calculating drop of potential, and that sort of thing, it is of no consequence what law of magnetisation you assume if you assume the permeability of the magnet as constant.

Mr. SPARKES: With reference to the rush of currents this was first noticed, to my knowledge, in 1886, but no measurement of intensity of the rush was made until that made by Dr. Fleming in 1891. Mr. Mordey was pointing out at the last meeting that the rush was most likely owing to the defect of some special type of transformer. Now the rush is noticeable in a transformer in which the iron is worked at a high induction. If you take an old type transformer it is pretty nearly certain that the induction is very much higher than the modern practice. If you take the five transformers mentioned by Dr. Fleming the induction is very high indeed. In Mr. Mordey's remarks I find that taking the 5 H.P. and the 10 H.P. and '91 type transformer at 15 H.P., and allow the transformers to be subjected to a greater induction than the periodicity it was designed for, it is very easy to see this rush of current. In making some thousands of experiments in each case the percentage of rushes was as follows: with the 5 H.P. there was very high induction indeed, 25 per cent. of slight rushes and 6 very fierce rushes; with the 10 H.P. there was 15 per cent. of slight rushes and 4 of fierce rushes; with the 15 H.P. there were 9 slight and 2 fierce rushes. With 83 periods we have with the 5 H.P. the slight rushes reduced to 10 and the fierce to 2; 10 H.P. goes down to 1·4 and 0; in the 15 H.P. nothing at all is observable. With 100 alternations the 5 H.P. goes down to 2 slight rushes and no fierce ones; in the 10 H.P. nothing occurs; and in the 15 nothing at all; now the higher the induction the greater the residual magnetism would be, and therefore the more intense the rush of current. I think Dr. Fleming's explanation of the cause of the rush is the right one.

Mr. WRIGHT: I do not understand why a special emphasis was laid on the good regulation of a small transformer. I find it is always as easy to obtain good regulations on a small transformer as on a large one, even when sandwiching by having very long coils, or rather the section of the coil spaced very long in comparison with its depth. The way to design transformers has been known a very long time, but the cost of the high efficiency transformer is excessive; to diminish the 1½ to 1 per cent. loss would almost double the cost of the transformer, and it becomes questionable how far you are to go. Then with the high efficiency transformer of 1892 a 20 H.P. transformer costs in up-keep per annum, including up-keep of iron, interest, and so on, the same as a three-wire feeder a mile-and-a-quarter long. It seems to me that even with the 98½ per cent. efficiency transformer there is no room inside the circle of a mile-and-quarter circle for transformers, owing to the enormous loss. This 20 H.P. transformer actually cost in up-keep £50 per annum. With reference to the two systems, I know that it used to take 25 lbs. of coal per unit sold on the high tension system; it now takes on the low tension system 2 lbs. of coal per unit sold over the same area supplying the same number of units. I think that must show that something ought to be done to cut out these or diminish the loss in some way such as Mr. Ferranti suggested in 1885.

Mr. WEEKS and Mr. HAYCRAFT also took part in the discussion. The meeting then adjourned.

THE ELECTROMOTIVE PROPERTIES OF THE SKIN OF THE COMMON EEL.*

By E. WAYMOUTH REID, Professor of Physiology in University College Dundee. Communicated by Prof. M. Foster, Sec.R.S.

(*Abstract.*)

1. The assumption that the E.M.F. of the current of rest of the skin of the fish is entirely due to mucin-metamorphosis, and that it is not possible to attribute it to the presence of glandular elements is negatived, in the case of the eel, by the absence of any such mucinous change in the superficial epidermic cells and by the presence of abundance of secretory throughout the structure.

2. The existence of considerable differences of potential between two contacts upon the outer surface of the skin, and the fact that such E.M.F. is capable of excitatory augmentation upon mechanical stimulation, coincides with the assumption that the E.M.F. of the current of rest is the outcome of glandular processes of variable activity, and is not compatible with the theory of origin of the E.M.F. in mucin-metamorphosis.

3. The reductions in the E.M.F. of the normal rest current following exposure of the skin to carbonic acid gas and to the vapour of chloroform, and the subsequent recovery upon admission of air, are strong evidence that the origin of the E.M.F. is in some active vital processes taking place in the skin, and it is reasonable to assume that these occur in its secretory elements.

4. The demonstration that the E.M.F. of the skin of the eel undergoes an excitatory variation as a result of electrical, thermic, and mechanical stimulation, is in accordance with what is known to occur in other glandular structures, and the fact that such excitatory change manifests itself as a positive variation of the current of rest agrees in the main with the phenomena observed in other cases.

5. The fact that chloroform narcosis excludes the possibility of the excitatory variation upon stimulation, at the same time as it reduces the E.M.F. of the normal rest current to zero, supports the assumption that the E.M.F. of the current of rest and that of the current of action originate in one and the same source.

6. Finally, the reduction of the E.M.F. of the normally directed current of rest by atropinisation and the complete absence of any excitatory variation under such conditions, are facts strongly in favour of the hypothesis that both the E.M.F. of the current of rest and that of the current of action are from a glandular source.

* Royal Society, received November 19th, 1892.

PARIS ELECTRIC LIGHTING.

THE Paris Municipal Council has just had laid before it the budget of expenses and receipts for the public and private electric lighting which it has established. The business on the agenda was the discussion of a report by M. Lyon-Allemand, presented by him in the name of the Third Commission, on the Halles municipal lighting station. The following is an account of the proceedings on the occasion under notice:—

M. LYON ALEMAND: Gentlemen,—It is very difficult to give at this moment an exact appreciation of the actual working of the Halles station. The late alterations introduced are too profound and too recent for us to yet know the consequences. The managers, in their report, appear satisfied, and there would be little reason to be so if only the figures which they furnish us, and the results of the working during the first half-year of 1892, were looked at.

M. MARSOULAN: I wish to point out the dangers which result, for the safety of the station, from the works executed by the engineers.

M. LYON ALEMAND: I have made the enquiry claimed by M. Marsoulan, as was my duty as reporter, and I have been able to verify the defects of the services as well as the improvements which have been introduced. On this subject, we cannot too heartily approve the propositions of the head engineer, who asks that a sum for extraordinary expenses be placed at the disposal of the director of the works, in order to meet any eventualities which may arise. The Third Commission might usefully nominate a delegation of three members to control the employment of this sum, and to submit every three or six months a report on the subject to the Third Commission and the Council. The measure which we propose would have a double advantage. In the first place, it would in the State have a veritable industrial working, by the suppression of delays incompatible with good management. Then, our sub-committee would be quite *au courant* with the working of an electrical station, which, in view of the development of this method of lighting, must arouse great interest. It is evident that every municipal industry should be directed in this way. If we examine the Budget scheme for 1893, we see that the provisions of receipts amount to 631,000 francs, and those of expenses to 629,265 francs, which shows a net profit of 1,735 francs. This result, at first sight, seems rather unsatisfactory, but on examining it more closely it will be seen that there is no need to complain, and that it is not of a nature to discourage the Municipal working of electricity. In short, if these figures be examined, they will be found to include (1) a sum of 31,550 francs for rent payable to the authorities, which is a net profit for them; (2) a sum of 18,980 francs for rent for the Halles basement (this basement was unoccupied before the starting of the station); and (3) a sum of 70,705 francs for interest and redemption of the capital of the first establishment. The Municipal station, all expenses paid, therefore meets the expenses of interest and redemption of the capital for the first establishment and realises a profit. Private electric lighting companies could not all say as much, and it would be ungracious for us to complain, the more so as the breaking of the agreement with the Belle Jardinière sensibly improves the situation. We think, also, that it is necessary to increase the size of the station, for we can no longer meet the demands, and, as the increase of production will be made with the same general expenses, the profits will proportionately increase. Consequently, we propose to the Council to write off the following two sums for receipts and expenses:—

Receipts.—Chap. 13, Art. 7.—Product of the Municipal electricity station at the Halles Centrales. Propositions of the managers and of the Commission, 641,000 francs. Expenses.—Chap. 16, Art. 27.—Municipal Electricity Station at the Halles Centrales. Propositions of the managers and of the Commission, 456,400 francs.

M. ALEXIS MUZET: The difference between the receipts and

expenses is large. It would seem that the receipts at the Halles station are higher than the reporter has let us understand.

M. LYON-ALEMAND: These receipts are only apparent; a certain number of expenses (redemption of capital, rent, rent for the occupation of the basement), a detailed enumeration of which figures in the budget, are not down as expenses, but should appear there. I ask the managers henceforth to supply us with a complete balance sheet of receipts and expenses of the Halles station.

Article 76 of Chapter 13 of receipts was adopted without change. Expenses.—Chapter 16, Article 25, electric lighting of public thoroughfares. Proposition of the managers, 543,600 francs; Propositions of the committee, 516,100 francs.

M. LYON ALEMAND: I decline all responsibility in regard to this decrease of 27,500 francs. The Budget committee has imposed it on me because it appears another commission is occupied with the re-organisation of this service.

The ACTING DIRECTOR OF WORKS: I insist on the re-establishment of this sum, at least in part. It is a question of controlling the companies and imposing fines on them when there is weakness or extinctions in their lighting. This service is organised; it works, and it is absolutely necessary to ensure the regularity of the electric lighting of our public thoroughfares.

M. PAUL STRAUSS (general reporter): I demand, on the contrary, the suppression of this sum of 27,500 francs in the name of the committee and the council itself which has decided that it would only pronounce on a special memorial concerning the control service of the electric light.

The ACTING DIRECTOR OF WORKS: But I repeat that this service has worked since electric lighting has existed. It is divided into six groups, which each has its sector. The surveillance hours are paid at the rate of 1 franc. The sum of 27,500 francs, fixed on this basis, is perhaps a little large on account of the shortness of the summer nights; it could not be much diminished.

M. RETIES: But your gas inspectors are sufficient for this service.

The ACTING DIRECTOR OF WORKS: The gas inspectors have something else to do.

The PRESIDENT: I corroborate the words of M. Strauss. It has been agreed that the managers should present a special memorial on the organisation of the control service of the electric light.

The ACTING DIRECTOR OF WORKS: Pardon me. It was only a question of the control of the canalisation and not of the control of the lighting, which was done long since.

M. LYON ALEMAND: I had proposed to reduce this sum of 27,500 francs, but it should not be suppressed altogether. I therefore ask the council to fix the whole sum at 531,000 francs instead of 516,100 francs.

M. PAULL STRAUSS: The Budget committee considered that the control was not organised as it should be. It has therefore organised the vote of credit up to the introduction of a special and detailed memorial. It is necessary for us to pay for a double surveillance service—diurnal for the canalisation, nocturnal for the lighting. We shall have 55,000 francs to write on the Budget. We cannot enter upon so large an outlay without complete explanations. I recognise the necessity of control, but I await a report frem the third commission.

M. LYON ALEMAND: I intend to ask the managers to present us this year with a special budget scheme similar to that of the Halles station for each of the municipal stations. I believe that the lighting produced by those stations costs us very dear, and in all cases it is certain we do not know exactly how much it stands us in. M. Gaufrés asks for the electric lighting of the Avenue de Clichy, and another Councillor that of the Place de la Bastille and the Rue de Lyon. We invite the Administration to enter into negotiations with the companies in the sector in which those two thoroughfares are situated in order to obtain that improvement. These companies may give electricity at the same price as gas; there is therefore no need to foresee an increase of expenses.

The PRESIDENT: That is a question which can be made the object of a special study. Several members of the council have asked for the electric lighting of different parts of Paris.

M. OPPORTUN: I have asked at different times for the electric lighting of the Square St. Jaques. The large traffic due to the proximity of two theatres and the passing of the numerous tramcars and omnibuses renders this improvement necessary. I add that, if it is wished to protect public morality, it forces itself upon us.

MR. CHARLES PEAN: Two years ago I asked for the lighting of the Boulevard Richard Lenoir.

M. LYON ALEMAND: I beg the administration to discover whether it is possible to substitute, at certain parts of Paris, arc lamps for "intensive" gas burners. I am of opinion that this change can be effected without increase of expense. I wish to remark that the quantities of electricity absorbed by the Halles increases each working period, and that, if it is not wished that the municipal station be exclusively employed for that use, it will be necessary either to suppress all improvements of this kind, or to acquire new machinery. The Commission, in accord with the Administration, asked you to vote for this purpose a sum of 444,950 francs. Now the Administration asks us to raise that to 481,450 francs, or an increase of 36,500 francs resulting from the application of different agreements entered into with the approbation of the municipal council.

SEVERAL MEMBERS: But the committee has not reported on this demand for an increase.

The PRESIDENT: There is reason to reserve this proposition.

M. LYON-ALEMAND: Under these circumstances I ask you, gentlemen, to fix Article 26 at 444,950 francs.

This proposal of M. Lyon-Alemand was adopted, and the proceedings terminated. From their general demeanour, it would appear as if a number of the members of the council, to use an Americanism, each had their own axe to grind, and they do not hesitate to impede a much-needed spread of the electric lighting of Paris in order to grind that implement.

NEW PATENTS—1892.

23,961. "Method of and apparatus for avoiding abnormal consumption of electric energy or overloading of the main current when starting alternating current motors." C. E. L. BROWN. Dated December 28th.

23,967. "Improvements relating to reflectors for electric arc lamps." H. H. LAKE. (Communicated by C. Coerper, Germany.) Dated December 28th. (*Complete.*)

23,985. "Improvements in telephonic transmitters." A. MARR. Dated December 29th.

23,988. "Improvements in electric arc lamps." J. MAIN. Dated December 29th.

24,008. "Improvements relating to electric lamps, and to apparatus connected therewith." A. L. SHEPARD. Dated December 29th.

24,009. "Improvements in the manufacture of pipes, or conduits for electric cables or other purposes, and in the means or apparatus employed therein." G. CROMPTON and J. CHAMBERS. Dated December 29th.

24,061. "A new or improved method of plating or coating aluminium or aluminium alloys." G. WEGNER and P. GUHRS. Dated December 30th. (*Complete.*)

24,071. "Improvements in the application of an electric current in the boiling or evaporating of solutions or liquids." E. L. C. SCHIFF. Dated December 30th.

24,088. "Improvements in or relating to dynamo-electric machines." H. H. LAKE. (Communicated by E. L. Zalinski, United States). Dated December 30th.

24,098. "Method of apparatus for starting non-synchronous single-phase alternating current motors." C. E. L. BROWN. Dated December 30th.

24,099. "Improvements in telegraphic communication between lightships and the shore." J. BROWN and R. L. PRUTTON. Dated December 30th.

24,122. "Improvements in electroliers, pendants, brackets, &c. W. BOWKER. Dated December 31st.

24,127. "Improvements in secondary batteries." F. KING. Dated December 31st.

24,147. "An improved automatic circuit closer for telegraph keys." C. WARREN-BRADFORD. Dated December 31st. (Date applied for under patents act 1883, section 103, May 31st 1892, being date of application in the United States.) (*Complete.*)

24,159. "Improved apparatus for forming the conductors of incandescent electric lamps." Sir C. S. FORBES, Bart. Dated December 31st.

1893.

36. "Improvements in electrical indicators." F. VILLIERS-STEAD. Dated January 2nd.

78. "Electro-magnets" R. VARLEY, Jun., and F. C. JONES. Dated January 3rd. (*Complete.*)

122. "Improvements in fastenings for securing metal arms or brackets to telegraph poles." SIEMENS BROTHERS & Co., LIMITED, and G. W. PERRY. Dated January 3rd.

133. "Means for obtaining electrical resistances." H. N. LAWRENCE. Dated January 3rd.

140. "Improvements relating to storage batteries and electrodes therefor." G. W. HARRIS. Dated January 3rd. (*Complete.*)

172. "Improvements in and relating to arc lamps." R. KENNEDY. Dated January 4th.

206. "Improvements relating to apparatus for producing light by means of alternating electric currents." Sir D. L. SALOMONS, Bart., and L. PYKE. Dated January 4th.

212. "Improvements in diplex and multiplex telegraphy." W. LANGDON-DAVIES, F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated January 4th.

222. "Improvements connected with electric belts and bands for curative purposes." N. MITCHELL. Dated January 4th.

229. "Improvements applicable to dynamos." H. G. READ. Dated January 5th.

236. "An electric railway signal for use in fogs or any other time." A. SMETHHURST. Dated January 5th.

238. "Improvements in and relating to the Deprez d'Arsonval galvanometer." H. W. SULLIVAN. Dated January 5th.

246. "Improvements in the method of casting frames or supports for electric battery plates or elements, and the apparatus therefor." E. W. TIMMIS. Dated January 5th.

257. "Improvements in apparatus for insulating electric wires or conductors." R. E. B. CROMPTON and H. J. DOWSING. Dated January 5th.

258. "Improvements in means or apparatus for use in the application of electricity for heating liquids and in means or apparatus for manufacturing the same." R. E. B. CROMPTON and H. J. DOWSING. Dated January 5th.

259. "Improvements in the heating of surfaces for the drying, heating, or other treatment of paints, oxides, or other matters by the aid of electricity, and in the means or apparatus employed therein." R. E. B. CROMPTON and H. J. DOWSING. Dated January 5th.

327. "Improvements in and relating to the coating of metallic surfaces with zinc." The LONDON METALLURGICAL COMPANY, LTD., and S. O. COWPER-COLES. Dated January 6th.

336. "Improvements in or relating to lightning-conductors." A. J. BOULT. (Communicated by Gustav Walch, Germany.) Dated January 6th. (*Complete.*)

344. "An apparatus for heating water or other liquid by means of electricity." B. P. SCATTERGOOD. Dated January 7th.

358. "A combined knocker and electric bell whereby an alarm is given should an attempt be made to remove the knocker." J. RIPPINGHAM. Dated January 7th.

387. "A combined electric launch and sailing vessel." K. D. BOWENS. Dated January 7th. (*Complete.*)

391. "Improvements in the manufacture of elements for electric or secondary batteries." E. HANCOCK and A. J. MARQUAND. Dated January 7th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

3,570. "Improvements in electro-therapeutic apparatus." F. GEORGE. Dated February 27th. The inventor takes two reels or bobbins, into which, placed end to end or otherwise, he inserts an iron core or cores, extending from one reel to the other. Upon one reel he winds two coils or helices, after the manner of ordinary medical induction coils, and he causes the current in the primary coil to be interrupted by means of a double vibrating current breaker, the connections of which are so arranged, that the current may be reversed at each interruption or otherwise, and he connects the terminals of the primary and secondary coils to the battery and binding screws in the usual manner. Upon the other reel he winds another coil, one terminal of which he connects to one pole of a galvanic battery, and the other terminal to a binding screw for the attachment of rheophores, and he connects the other pole of the battery to another similar binding screw by means of a second conductor. By means of these conductors and rheophores, he conveys to the patient a continuous current of electricity, at the same time impressing the said current with the induction due to the interrupted, alternated or otherwise varied current through the primary coil above mentioned, by means of the continuous iron core or cores. 8 claims.

5,711. "Improvements in the manufacture of seamless tubes or conduits for electrical and other purposes, and in the apparatus employed therein." J. R. THAME. Dated April 2nd. The inventor takes pulp prepared from any suitable raw material or waste, which he moulds into a sheet or sheets of the desired shape and thickness, preferably leaving the edges splayed or tapered, and in moulding the said sheet he arranges the pressure applied, so that the middle of the sheet receives more than the splayed or tapered edges. After having made the sheet in this manner, he places the same on a "felt" or "wire," or like device, and bends the whole round a mandril of the right diameter. Having wrapped the sheet of pulp around the mandril, with the splayed or tapered edges of the pulp sheet overlapping each other, the carrying wire or felt is next wrapped around the bent pulp sheet, and the whole is then transferred and pressed into a suitably constructed mould. The tube so made is afterwards dried in a suitable drying apparatus. The tubes or conduits having been thoroughly desiccated, are rendered the same more or less as waterproof as possible, and at the same time are given a high insulation by immersion in a bath containing a liquid hydrocarbon, which may have approximately the formula $C_{24}H_{16}O_4$ in combination with asphaltum, bitumen, stearine pitch, or other suitable solid hydrocarbon or hydrocarbons. 5 claims.

8,031. "Improvements in apparatus for heating and welding by the electric arc." H. HOWARD. Dated May 9th. The inventor employs a movable connection in such manner that the point of attachment of the conductor to the work or anvil is always as nearly as possible opposite to the end of the carbon. 3 claims.

8,126. "Improvements in dynamo-electric machines." G. J. PHILPOTT. Dated May 12th. The brushes are set as usual upon a sectional commutator of any ordinary type and in any desired position, from these brushes a continuous current is collected which is used to excite the field magnet of the said machine and also to supply an external circuit. Upon the spindle of the said machine are fixed two insulated collector rings, one of the said rings is connected to a segment exactly opposite to the first, and on the other side of the commutator. From brushes set on the said rings may be collected an alternating current and the machine will still remain self-exciting. 2 claims.

8,811. "Improvements in and relating to recording electric meters." G. MENGARINI. Dated May 23rd. The apparatus contains a coil of a suitable number of convolutions. This coil is usually in two or more sections. Within this coil another coil is suspended from above by two wires, and a third wire descends from the coil to a point of attachment below. Means are provided for regulating the tension of these wires. The suspended coil is of a suitable wire, and it is in circuit with a suitably adjusted resistance. When the instrument is uninfluenced by current the suspended coil stands with the plane of its convolutions crossing at right angles, the convolutions of the outer coil. When a current passes through the coils, the suspended coil is deflected from this position. On the suspended coil is an arm, and this arm operates to move a long horizontal index around an axis. The index carries a pen which traces a line upon paper lapped around a drum. The drum is slowly rotated by clockwork whilst the pen is moved by the coil in a direction at right angles to the axis of the drum. 3 claims.

9,079. "Improvements relating to the electrolytic extraction of metals, and to the electrolysis of other substances." C. HOEPFNER. Dated May 28th. According to the invention the carbon substance of electrolytic anodes is wholly or partly replaced by ferrosilicon. 3 claims.

9,423. "An improved holder for electric incandescent lamps." H. H. GRENFELL. Dated June 3rd. According to this invention the lamp is cemented or otherwise firmly secured in a holder of vulcanite or of other suitable insulating material, a pair of metallic contacts being provided at the base of the holder from which contacts conducting wires for current are led to the lamp. The other contact is of annular form, and the conducting wire therefrom is preferably led in a direct line to the end of the lamp filament, and passes into the lamp bulb at one side thereof. The first-named or central contact is formed as a screw or plug, and constitutes, also, a mechanical connection whereby the lamp-holder may be secured to a wire holder or terminal, also of insulating material, carrying a pair of separate metallic contacts, to which the leads from the generator are connected. One of the said leads terminates in one of these contacts which is a metallic socket adapted to engage securely and to make a good electrical connection with the screw or plug above referred to, and the other lead terminates in the other contact, which is a metallic ring carried by the wire-holder, which ring, when the socket in the wire holder and the screw or plug of the lamp holder are brought together, makes contact with the aforesaid ring on the lamp-holder.

9,606. "Improvements in apparatus for holding telephone receivers, and for placing in or out of circuit either the call or the transmitting apparatus." W. P. THOMPSON. (A communication from abroad by S. Stein, jun., of Stuttgart.) Dated June 6th. The carrier or support is made adjustable, so that it can be placed at any suitable height, and can also be easily adjusted sideways. The bell conductor can be disconnected, and also the telephone connected with the conductor automatically as soon as a person's arm is rested for the purpose of writing, &c., on the movable writing desk fitted to the apparatus, whilst, when the conversation is ended and the arm removed from the desk, the disconnection of the telephone and the connection of the bell conductor will be also automatically effected. 4 claims.

9,689. "Apparatus for supplying depolarising or other liquids to a series of electric batteries." V. JEANTY. Dated June 8th. The apparatus is composed of a main closed vessel containing the liquid to be supplied to the series of batteries, and of a distributing open vessel placed beneath the former and connected therewith by a first pipe through which the liquid descends from the upper to the lower vessel, and by a second pipe which determines the flow of the liquid intermittently. 12 claims.

CORRESPONDENCE.

Mr. Thwaite's Scheme.

To attempt even a favourable criticism of Mr. Thwaite's plans and ideas short of absolute acceptance of all his opinions is to bring down a very steam hammer of wrath. He is always so fully persuaded that his critics know nothing of the special environment of the district, taken *pro tem.* under the shadow of Mr. Thwaite's wing. As a Crompton by ancestry, your reviewer requires no great local enlightenment of Lanchashire and its business, nor does he require to refer to Mr. Thwaite's book anent the introduction of moisture to cotton mills, and if moisture be not essential, why introduce it? Mr. Thwaite begs the question, and his references to India, Fall River, &c., are not valuable. India is damp and warm; Alsace I am told is not a thirsty land, and of Fall River I can only add it was damp enough there, and at Lowell, when I was there. Also where is Manchester but in a hill district, even of itself on a low plain, though by the way there is little cotton now manufactured in Manchester.

Mr. Thwaite doubts the heating effect of work reconverted into heat, but he does not answer the question "what becomes of the horse-power." A few figures may convince him. Assuming 772 horse-power gets into a factory, we have 33,000 heat units per minute. In a factory of four flats, working nine hours per day, this is equal to raising ten tanks of water in each room from hot-well temperature to the boiling point, each tank holding 400 gallons or being a 4-foot cube, and this amount of heat is of such importance, that in summer time windows are opened because of the excess of heat generated. We again ask Mr. Thwaite where else goes the horse-power? Steam heating is not so unimportant an item, and granting that it is important only half the year—a mistake—the appliance to generate heat must be equal to the maximum winter duty, and this is a question

which must be faced, for it is just this heating which will still demand a boiler or the equivalent in some form. In dye and bleach works, India-rubber and calendering, paper making and similar processes, the heat question is more important than the power question. But, where is the mill which uses 1,000 tons of coal weekly? 50 is the tonnage of a standard factory and the 200 tons saved per week dwindles to 10 tons, costing £150 a year, an item not of such weight as to turn the scale in itself. With regard to the cost of a horse-power hour in London, a friend of your reviewer, also a Lancashire man, is evaporating water at the rate of under 21 pence per 1,000 gallons. At 20 lbs. per horse-power hour this would work out considerably under the $\frac{1}{10}$d. to which Mr. Thwaite demurs. I cannot publish places and names, but am ready to give them to the editors of the REVIEW if confirmation is needed. In the meantime I, myself, am the authority, for quoting which I have Mr. Thwaite's example, and what has been done can be done, but with high priced coal the figure at the same works was 54 pence per 1,000 gallons, and Mr. Thwaite can make his own figures per horse-power. Small engines, of course, have no figures, but *apropos* of small engines, I remember once speaking to a man about his wasteful engine, and he showed me how he used in some process of his business all the steam he could get from his boiler. He did but allow it to turn an engine *en route*, and any engine was fit for this duty. It was an example of a large class of heat users who constitute what it pleases Mr. Thwaite to call a "shadowy objection." It is not possible to accept any scheme *en bloc* in which no provision is made for heat, apart from power and such provisional non-acceptance need not be taken as evidence of objection to the principle involved so much as an understanding, based on actual experience of the needs of steam users, of the elements for success necessary to be contained in any transmission scheme which shall be other than a combination lighting and small power undertaking. I will not follow Mr. Thwaite into the question of the railway charges, or whether it costs more or less than ·83d. per ton mile to carry coal. Our railway directors choke traffic by high rates, because they have not the ability to cope with what it would be, if encouraged by fair rates. On this subject Mr. Thwaite should look up some of the American bulk rates. It is because of what might be done by men of real ability in railroading, rather than of what is being done, that there is still hope for the system of carriage of energy in the solid.

Your Reviewer.

"A Strange Incident."

Your issue of December 16th contains a communication entitled "A Strange Incident," and signed "Mystified."

As I understand the case, one brush of an 80-volt 200-ampère shunt wound dynamo was lifted "with the pilot lamp, and voltmeter in circuit only." The voltmeter jumped up to 120 volts, and the lamp became "quite incandescent."

The phenomenon is easily explained, and is simply due to the discharge of the field magnetism which generates a current in the field coils. This current flows through the pilot lamp and voltmeter, which are connected in parallel with each other and the field circuit.

The voltage of the current generated is by no means limited to the ordinary E.M.F. of the machine, but might rise to many times as much, if the discharge of the magnetism is very rapid.

The case is similar to the generation of E.M.F. in an induction coil by the discharge of the magnetism of the core.

If the armature is running at full speed, or even when slowing down, then the lifting of the brush suddenly stops the field current and the magnetism discharges. Even if the armature is actually brought to rest, *provided it is done more quickly than the magnetism discharges*, and the brush is then lifted, the current generated in the field coils by the discharging magnetism is no longer short-circuited by the armature, and consequently shows in the voltmeter and pilot lamp. A number of lamps connected in circuit would also act as a shunt and take most of the current, instead of the voltmeter and pilot lamp, the current being limited by the high resistance of the field coils in which it is generated.

The only "strange" thing about the "incident" is that the dynamo and engine should stop quickly enough. The dynamo in question was about 25 H.P., and this, with a corresponding engine, would ordinarily run a minute or two after the steam is shut off, and in the meantime the magnetism would have discharged.

Francis B. Crocker.

New York, *January 3rd*, 1893.

Depreciation of Machinery.

I quite agree with the remarks in your last issue on the above subject with reference to the report issued by the St. Pancras Vestry as regards their electric lighting plant. I cannot but think that whoever advised them "that no large provision for depreciation ever will be necessary," could have had but limited experience in this connection. It is well known that a percentage for depreciation is necessary on all engineering plant, the amount varying according to the wear and tear to which the plant is subject to, whether it is likely to be improved or rendered more or less obsolete. It is usual with ordinary machinery which is kept in first-class order, and the cost of repairs paid out of revenue, to allow of a depreciation of not less than 5 per cent. per annum. In the case of high speeded machinery, or where the duty is severe, or where the plant is likely to be improved, this is often increased to 7½ per cent. With engines and boilers which are subject to greater wear than machinery, the depreciation allowance is usually 7½ per cent. If during the next 10 or 15 years electrical science advances in anything like the ratio it has done during the last, much of the plant may be superseded. Is it right, therefore, that it should at that date stand on the books at anything like its new price?

Referring to some of the high-speed engines employed for electric lighting, I do not think a 10 per cent. depreciation would be very excessive, as when serious repairs are required it would be practically like making a new engine. I may add that I was recently engaged in an important case in which the question of the valuation and depreciation of plant arose, and the judge ruled that a substantial amount for depreciation must be allowed. It may be urged, on the other hand, that if the allowance for depreciation is considerable, the value of the plant will soon stand for very little on the books. To obviate this, it should be re-valued, say, every 10 years, the following points being borne in mind: (1) Make, (2) age, (3) condition, (4) whether out of date, &c. Another advantage, at any rate, in allowing a fair amount for depreciation, is that the owners are on the safe side.

M. Powis Bale.

High Frequency Experiments.

In your issue of the 13th inst., Dr. W. S. Hedley refers to my high frequency experiments described in your same issue, and quotes as bearing on them a paragraph from a paper that appeared some time ago in your columns. In this paragraph it is assumed that 8 watts (4 volts and 2 ampères) will give sufficient initial energy for the high frequency apparatus. As these figures, if applied to my experiments, would convey a very misleading impression as to the amount of energy necessary, I should like to point out that the initial energy in my apparatus, exclusive of what is absorbed by the resistance and lost in heating the contact breaker, appears to be about 350 watts, or not far off half an electrical horse-power.

While on this subject I should also like to mention that though practically no sensation is experienced when the body is introduced so as to form a circuit between *one* pole of the high frequency coil and earth, it is very different when the body is inserted between the *two* poles of the coil. When this is done the sensation experienced is very severe, in fact, quite unbearable. It is somewhat curious to note that while the physiological effect is thus infinitely greatest when the body is connected between the two poles of the coil, the lamp filament, as mentioned in my paper, incandesces to a lesser extent when connected in this way than when inserted between one pole and earth.

A. A. C. Swinton.

January 14th, 1893.